MINING WORLD

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FIFTY CENTS **DECEMBER 1961**

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The drilling speed of a drifter . . . combined with the greatest handle-ability ever built into feed leg drills . . . bring top drilling performance to your underground workings. Put one to work in your own mine, and compare these outstanding Gardner-Denver advantages:

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ASARCO: Buyer, smelter, refiner of gold, silver, lead, copper and zinc ores and blister copper, concentrates, mattes and residues. Fourteen domestic and four Mexican plants located for maximum accessibility as follows:

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Amarillo, Texas
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Hayden, Arizona
El Paso, Texas
Tacoma, Washington
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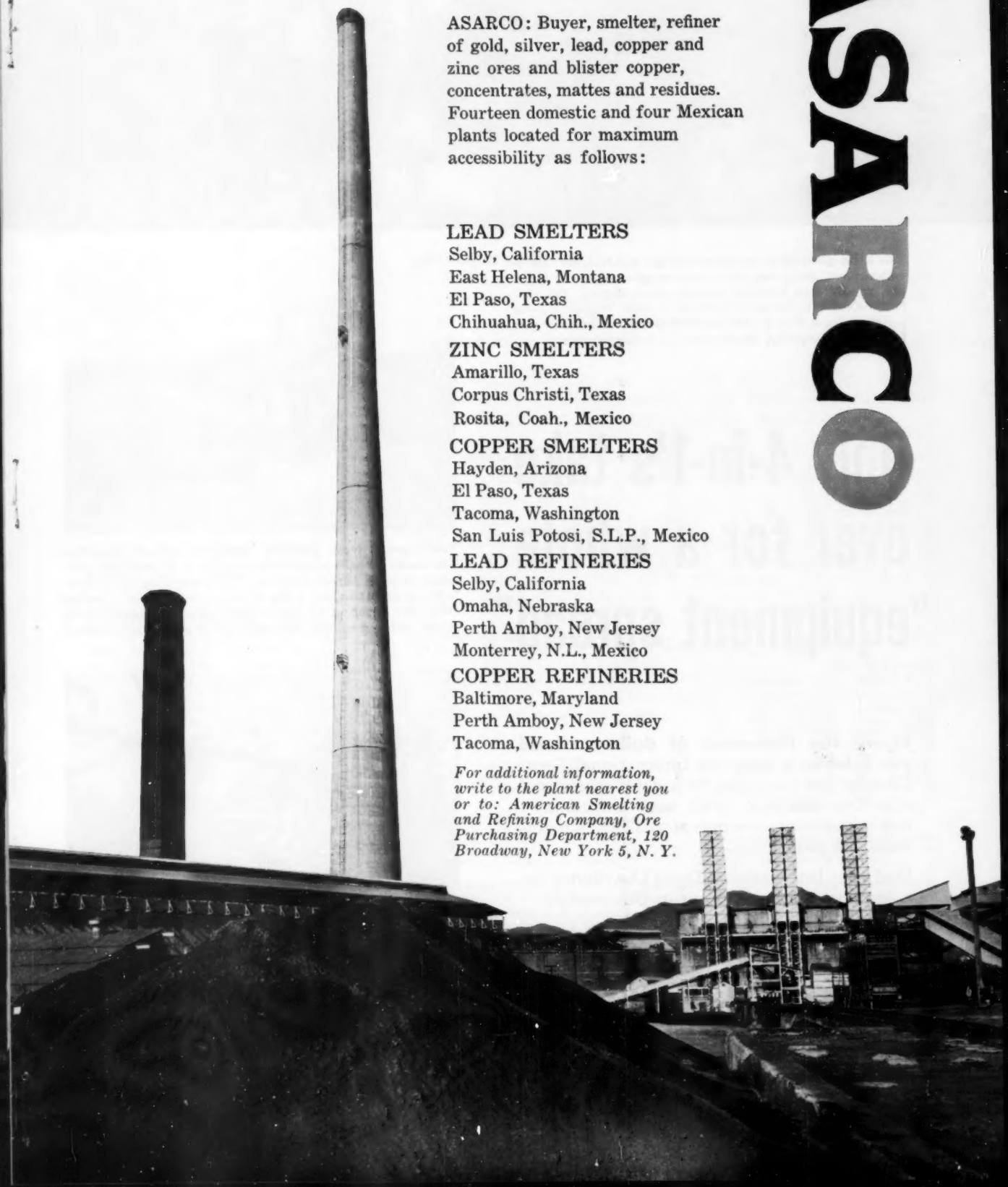
LEAD REFINERIES
Selby, California
Omaha, Nebraska
Perth Amboy, New Jersey
Monterrey, N.L., Mexico

COPPER REFINERIES
Baltimore, Maryland
Perth Amboy, New Jersey
Tacoma, Washington

For additional information, write to the plant nearest you or to: American Smelting and Refining Company, Ore Purchasing Department, 120 Broadway, New York 5, N. Y.



You'll be getting a machine that can bulldoze, do "carry-type scraper" and grader work—and can give you power-shovel-like, pry-over-shoe break-out force for tough digging. This TD-9 Four-in-One is punching a hole into a West Virginia hill—for punch mining a 5' to 7' coal seam. Note that the operator gets full-sized, full-capacity, depth-controlled bulldozer action!

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Figure the thousands of dollars ahead you'll be by letting one International Drott Four-in-One take over for several specialized rigs. *One machine (with uses unlimited)—one investment—one operator.* That's streamlining for profit!

Dial your International Drott Distributor for a demonstration of a Four-in-One today!

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Drott Manufacturing Corp., Milwaukee 15, Wisconsin

INTERNATIONAL® DROTT®

You'll profit from positive clamshell bottom dumping—to handle all types of materials, in all kinds of conditions, even where obsolete buckets fizzle out. This fast-working TD-15 Four-in-One is saving an hour a day in bucket clean-out time, loading sticky clay. Opening the Four-in-One's clam pulls material from bucket surfaces; gravity down-pull assures prompt self-cleanout!

You'll clam-on to anything you want to move and handle it fast! This TD-9 Four-in-One clam-handling a tree does all the land-clearing and load-out work at a pit producing bank gravel. This "bucket with the bite" easily grabs, carries, and loads stumps, boulders, and other "impossibles"—with the "man in the seat" in full charge!

GRAB SAMPLES from the mail

From a Grateful Librarian

Dear Sir:

A big thanks is sent to you today.
You've aided my work in a very good way.
The "Company Index" News in September—
Is a long needed device to help me remember.
So now when an inquiry comes rolling in here—
"What did such and such company do **sometime** this year?"
The role of Librarian will relax just a bit
As I use your fine index . . . and take time to sit!
PLEASE keep this service going, till the end of **each** year . . .
When your annual index is received with a cheer!

J. R. Evanger
Technical Librarian
Climax Molybdenum Company

Interest in Computers

Dear Sir:

My personal copy of your June issue dealing with computers has been circulated to the Rich Electronic Computer Center of the Engineering Experiment Station here at Georgia Tech. They have indicated an interest in securing an additional copy for their library. If you will send such a copy to me, I will forward it promptly to them.

It may be of interest to you that the Engineering Experiment Station at Georgia Tech is equipped with a general purpose analog computer of moderate size, a Univac Scientific (ERA-1101), and a Burroughs 220. The ERA-1101 has a word length of 24 binary bits, 16,000 words of magnetic drum storage and 4,000 words of magnetic core storage. The Burroughs 220 has a word length of 10 decimal units and 5,000 words of magnetic core storage. The ERA-1101 can perform 33,000 additions per second; the Burroughs 220 can perform 5,400 additions per second.

John E. Husted
Head Mineral Engineering Group
Georgia Institute of Techonolgy

"Offer a Steady Job"

Dear Sir:

You just proved that you are an editor and not a "stick-in-the-mud" technical robot.

I'm referring to Jim Thompson's article "Why didn't I think of that?" in the July issue of MINING WORLD.

Suggest you offer that man a steady job.

W. M. Aubrey
Lebanon, Pennsylvania

MINING WORLD

VOL. 23, No. 13 — **December 1961**

Electronics and automation move copper ore swiftly from the Lavender pit through primary crushing to fine ore storage, with the aid of several electronic marvels that are the pride of the Phelps Dodge concentrating department at Bisbee, Arizona 16

Productive capacity of the adit and crusher on the Storke Level of the Climax mine was determined fast and efficiently by use of a Monte Carlo mathematical model and an electronic computer 19

Conveyor haulage for the Boron open pit of the U. S. Borax & Chemical Corporation had been planned since early pit development, but was not practical until recently. The new system, just installed, has cut truck haulage costs in half, and increased mine production 23

Diamond drilling to depths greater than 5,000 feet is now being accomplished in Australia as the north and south extensions of the famous Broken Hill lode are investigated 26

Annual index lists all material published during 1960, and is cross-referenced so you can find articles by title, author, type of mineral, or location 32

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CAPITOL concentrates

GOVERNMENT ACTION AND REACTION AFFECTING MINING

Silver Industries Meet with Treasury as "Free" Silver Dwindles . . .

Conferences have been held between silver producers, silver users, and the Treasury Department, but do not seem to have resulted in a meeting of minds. Just the same, the fact that the Treasury officials were willing to have conference is encouraging.

"Free" silver held by Treasury was 42,637,270 ounces on November 1; down from 43,710,281 the day before.

Silver users seem to think that stopping the sales of Treasury silver and freeing it from the Silver Purchase Act will result in cheaper silver. Silver producers feel that stopping the sale of Treasury silver will cause the silver price to rise. What is needed is to reconcile these diametrically opposed opinions.

Why is Wilderness Legislation Needed When Existing Laws Can Be Used? . . .

No clear explanation has been offered as to why there is such persistent effort to enact the Wilderness bill (S. 174) when there already is plenty of authority under present laws to create such areas, and that authority has been used in a large way.

The October 1961 issue of "Our Public Lands" published by the Bureau of Land Management contained the following report of wilderness areas created during 1960:

"Half a million acres were added to the national forest wilderness system during 1960, bringing total acreage to more than 14,500,000 acres, most of it in the West. Largest addition last year was the Glacier Peak Wilderness, 458,505 acres in Washington's Cascade Mountains. Other additions were the 6,051-acre Wheeler Peak Wild Area in New Mexico and some 3,000 acres added to the Cucamonga Wild Area in California. The Bridger Wilderness in Wyoming and the San Jacinto Wild Area in California were reclassified from primitive areas."

Obviously, something more is back of the current drive for legislation than has been brought out.

Public Hearings Ordered By Tariff Commission on Many Minerals . . .

The United States Tariff Commission has issued a notice to the effect that in response to Senate Resolution 206, 87th Congress, several investigations have been instituted and public hearings ordered as follows:

Investigation No. 332–26, relating to the **lead** and **zinc** industries, for the purpose of bringing down to date the factual information contained in the Tariff Commission's report to the Congress in February 1960. The public hearing is scheduled for January 30, 1962.

Investigation No. 332–32, relating to the **mercury** industry. A hearing is scheduled for February 20, 1962.

Investigation No. 332–29, relating to the **fluorspar** industry. A public hearing will be scheduled for January 1962.

Investigation No. 332–41, relating to the **beryllium** industry. The public hearing will be held April 17, 1962.

Investigation No. 332-42, relating to the **cobalt** industry. The public hearing is scheduled for May 15, 1962.

Investigation No. 332–43, relating to the **manganese** industry. The hearing is scheduled for June 12, 1962.

Interested persons who wish to be heard at any of these hearings should notify the Secretary of the Tariff Commission, Washington 25, D. C., at least five days prior to each hearing.

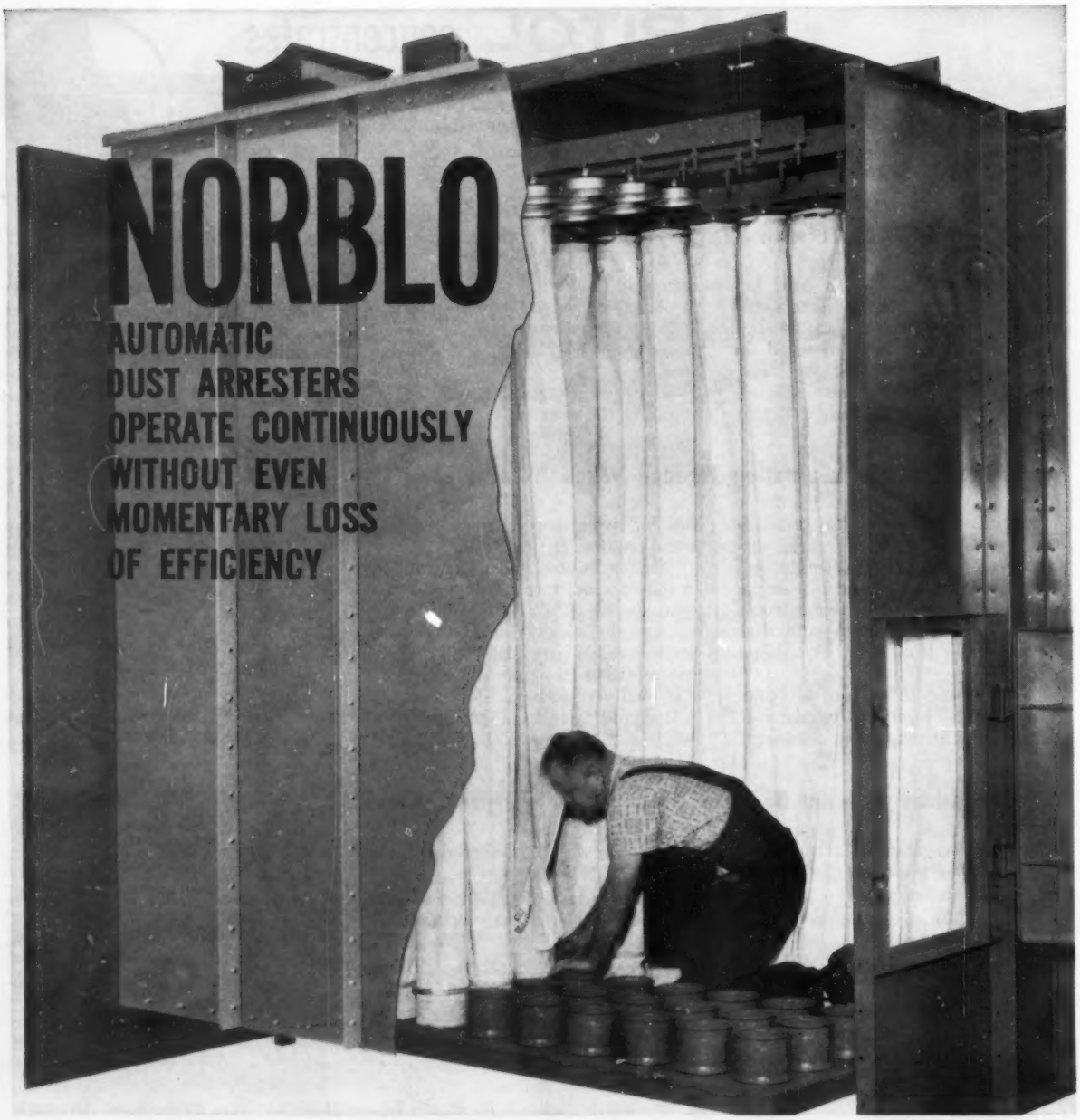
No Revenue to States or Schools From Wilderness or Wildlife Areas . . .

The Bureau of Land Management has distributed over $21,000,000 to 27 states from funds which were received in the first six months of 1961 from grazing leases, timber sales, rentals and royalties and federal mineral leases. Wildlife areas contributed exactly $0.0 in funds to the states for school and other uses.

Lead-Zinc Subsidy Regulations Due Soon From Interior Department . . .

An Interior Department official has said that regulations for the operation of the lead-zinc subsidy program under Public Law 87–347 may be ready for study by the mining industry sometime in November. Generally, there is a 30-day waiting period during which to hear criticisms and suggestions before regulations become effective.

The act is financially based on the calendar year, while departmental appropriations are for the fiscal year, June 30 to June 30. It will be necessary, therefore, for a special appropriation to be provided to pay for the subsidy for the first six months. Such an appropriation cannot be authorized until the Congress reconvenes January 10, 1962.



Periodic cleaning, repair or replacement of bags, and minor maintenance can be accomplished while the collector remains in operation. One compartment, as shown above, can be isolated in the Norblo design, with all mechanical parts outside the gas stream. Continuous cyclic shaking, by compartment, allows operation without interruption. ■ This is why in modern plant operations you'll find an increasing preference for Norblo Automatic Bag Arresters. Where efficient production requires continuous operation more and more industries specify Norblo Dust Arresters. Over 80% of the cement industry relies on Norblo equipment for drying, grinding and finishing operations. ■ Buell-Norblo equipment can play an essential part in your process. Write for complete information on any type of dust collection problem. Buell Engineering Company, Inc., Dept. 66-L, 123 William Street, New York 38, New York. Northern Blower Division, 6407 Barberton Avenue, Cleveland, Ohio. Electric Precipitators · Cyclones · Bag Collectors · Combination Systems · Fans · Classifiers.

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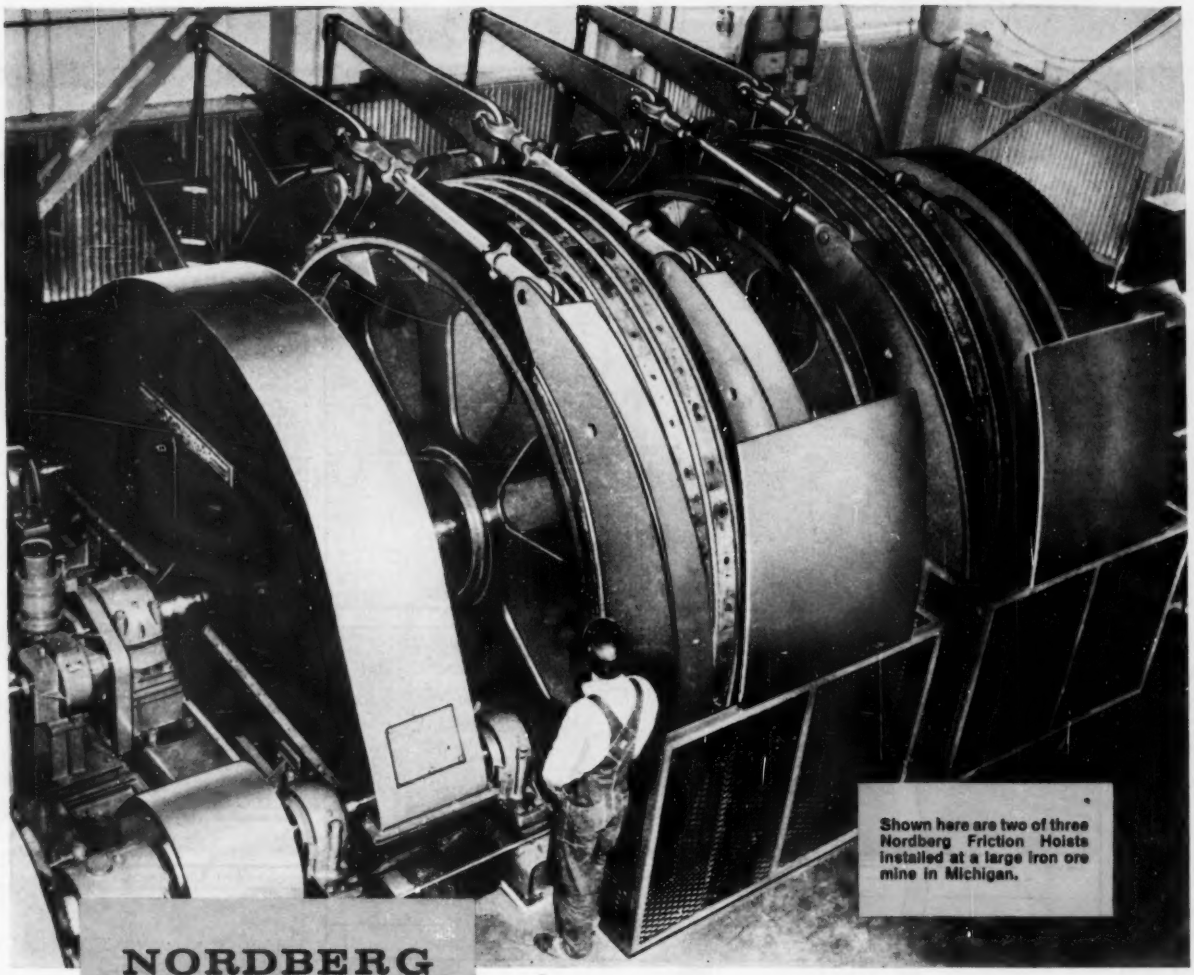

Shown here are two of three Nordberg Friction Hoists installed at a large iron ore mine in Michigan.

NORDBERG Friction Type MINE HOISTS

. . . used for economical SERVICE and PRODUCTION HOISTING

Where applicable, service or production hoisting can be economically handled with Nordberg Friction Type Mine Hoists . . . built for either counterweighted or in-balance operation, geared or first motion electric drive, manual and/or fully automatic control.

Outstanding features of the Nordberg design include: one-piece welded steel drum; anti-friction roller bearings throughout; a choice of pressure applied—pressure released or gravity applied—pressure released brakes, all with emergency gravity back-up.

In addition to friction types, Nordberg *Drum Hoists* are in wide usage throughout the world; are available with manual, push-button semi-automatic, or fully automatic control.

It will pay you to let Nordberg's 65 years of specialized mine hoist experience help you select the right type and size hoist to best meet your specific needs.

NORDBERG MACHINERY

NORDBERG MANUFACTURING COMPANY
Milwaukee 1, Wisconsin

MH161

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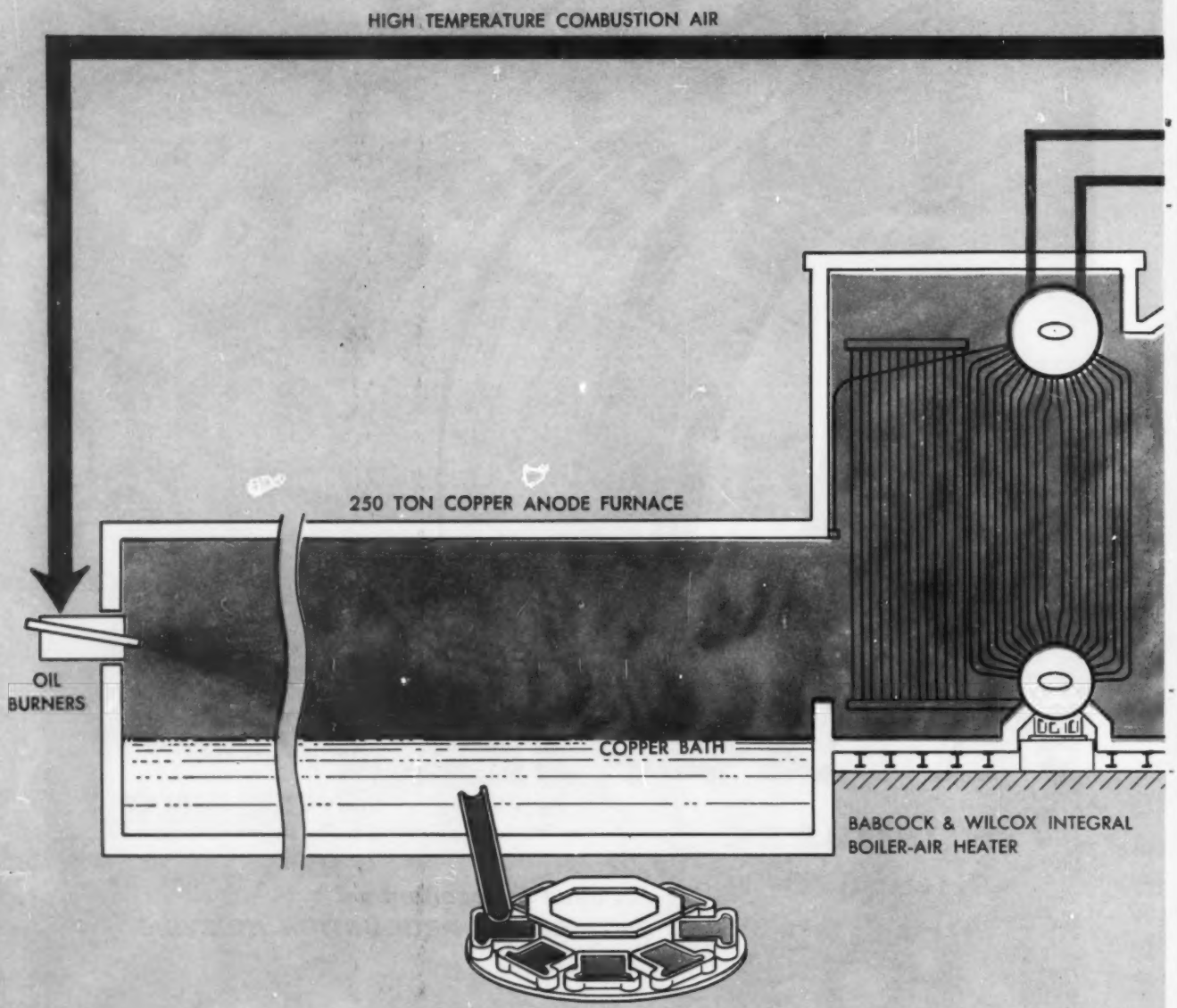
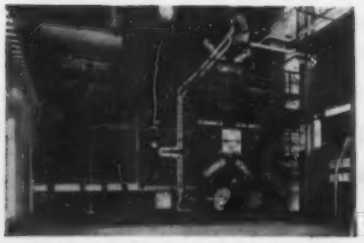
ST. LOUIS • SAN FRANCISCO TAMPA • WASHINGTON • WICHITA, KANS. • TORONTO • VANCOUVER • JOHANNESBURG • LONDON • MEXICO, D. F.



B&W integral boiler-air heater increases copper production



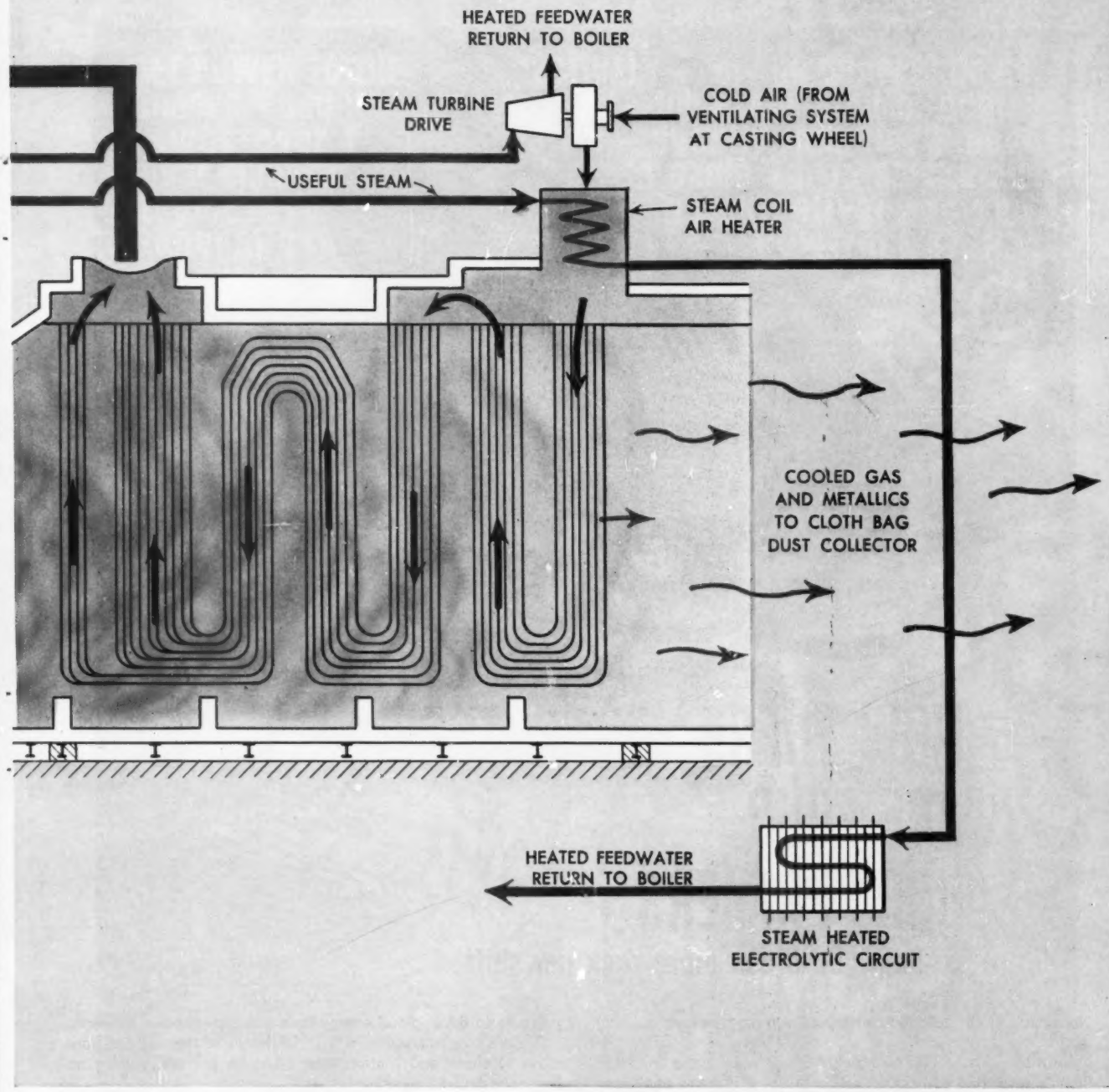
B&W waste heat boiler conditions flue gas for air heater and produces enough steam for plant base load requirements.

B&W air heater heats combustion air for copper anode furnace and cools flue gas for zinc oxide recovery.

Lewin-Mathes Co., a division of Cerro Corp., recently installed a copper anode furnace at their Monsanto, Ill. plant where refined copper and tubing are produced.

Flue gas from this furnace is highly corrosive with high solids carryover. It rapidly clogs conventional heat recovery units.

Babcock & Wilcox's solution to this problem is an integral waste heat boiler-air heater which pro-



and cuts operating costs for Lewin-Mathes Company

duces maximum useful heat recovery from process waste gas.

The B&W waste heat boiler conditions the flue gases, leaving only dry dust particles which flow freely through the air heater. Enough steam is generated to fulfill the plant's base load requirements.

Maximum furnace efficiency is achieved with high temperature combustion air from the air heater. Using B&W's extensive experience in heat transfer apparatus, the air heater is the reverse of usual design. Combustion air flows through the tubes; gas over the tubes. Gas side deposits are effectively removed through lance doors located for complete coverage of tubular surfaces.

Copper alloy tubing, produced by Lewin-Mathes, is used in the final section of the air heater. In this highly corrosive, low temperature gas zone, steel tubing would rapidly corrode. Copper tubing has performed exceptionally well.

After cooling, exit gas is sent to a bag collector where zinc oxide is recovered and clean gas discharged.

For help in solving your heat recovery problems, call your nearest B&W representative or write: The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

Babcock & Wilcox

NOW THERE ARE FOUR "HDP" PRIMERS

to help you break more rock per shift

Now you can get **all** the economy of non-cap-sensitive blasting agents.

With the introduction of the HDP-5, you now have a complete "family" of Du Pont high Detonation Pressure Primers, especially created to develop full rock-breaking power from lower-priced blasting agents such as nitro-carbo-nitrates, Du Pont "Tovex" water compatible slurry, and prill/oil mixtures.

All four "HDP" Primers contain a high-density explosive which develops a velocity of almost 5 miles/second and a temperature of about 7500°F. This combination gives the very high detonation pressure to develop full energy from non-cap-sensitive products.

There's no nitroglycerin in "HDP" Primers, so they are less sensitive to shock and friction than dynamite primers. There's no headache causing ingredient.

And assembly to "Primacord" or caps is easy to make, through holes in the primers. You can even do it with heavy work gloves on.

Your Du Pont explosives representative or distributor can arrange for you to try out new "HDP" Primers now. Call him for details. Or for a copy of our new bulletin on the subject, write Du Pont, 2446 Nemours Building, Wilmington 98, Delaware. **EXPLOSIVES**

Meet the "HDP" Primer Family

HDP-1

PROPERTIES: Weight 1 lb. • Detonation Velocity 24,000 fps • Highly resistant to water and oil • Dimensions—3" diameter cylinder 2½" long • Two axial holes—1 for "Primacord" and 1 for electric blasting caps or MS delay electric blasting caps • Packed 48 primers per case—48 lbs. net

USE: Recommended for priming all NCN products, "TOVEX" gel, and prill/oil mixtures, bulk loaded or cartridged, in holes of 4" diameter and larger.

HDP-2

PROPERTIES: Weight ½ lb. • Detonation Velocity 24,000 fps • Highly resistant to water and oil • Dimensions—3" diameter cylinder 1.4" long • Two axial holes sized for use with "Primacord" only • Packed 100 primers per case—50 lbs. net

USE: Satisfactory for priming bulk loaded NCN products and prill/oil mixtures in holes of 4" diameter and larger.

HDP-3

PROPERTIES: Weight ⅓ lb. • Detonation Velocity 24,000 fps • Highly resistant to water and oil • Dimensions—1¾" diameter cylinder 3½" long • Single axial hole centered in the primer sized for "Primacord", electric blasting caps and MS delay electric blasting caps • Packed 150 primers per case—50 lbs. net

USE: Recommended for priming all bulk NCN products, "TOVEX" gel, and prill/oil mixtures in holes ranging from 2" to 4" inclusive in diameter.

HDP-5

PROPERTIES: Weight 5 lbs. • Detonation Velocity 24,000 fps • Highly resistant to water and oil • Dimensions—5¼" diameter cylinder 4¼" long • Two axial holes sized for use with "Primacord" only • Packed 12 primers per case—60 lbs. net

USE: Recommended for priming all NCN products, "Tovex" gels and prill/oil mixtures, bulk loaded or cartridged in holes of 6" diameter and larger, under exceptionally severe conditions.

Better Things for Better Living... *through Chemistry* DU PONT

4 NEW MARION 11-YARD SHOVELS to attack TACONITE

Two major mining companies have each ordered two type 191-M shovels for their taconite operations in the toughest digging in North America. These machines weren't bought on price cuts or out-of-the-yard deliveries. They were bought because the type 191-M has proved, in actual competitive performance, what it can do in taconite, material so tough it will scratch diamonds.

It's no accident that more Marions mine taconite than all competitive makes combined. It's no accident that operating men recommend Marions, because operating men are judged on results.

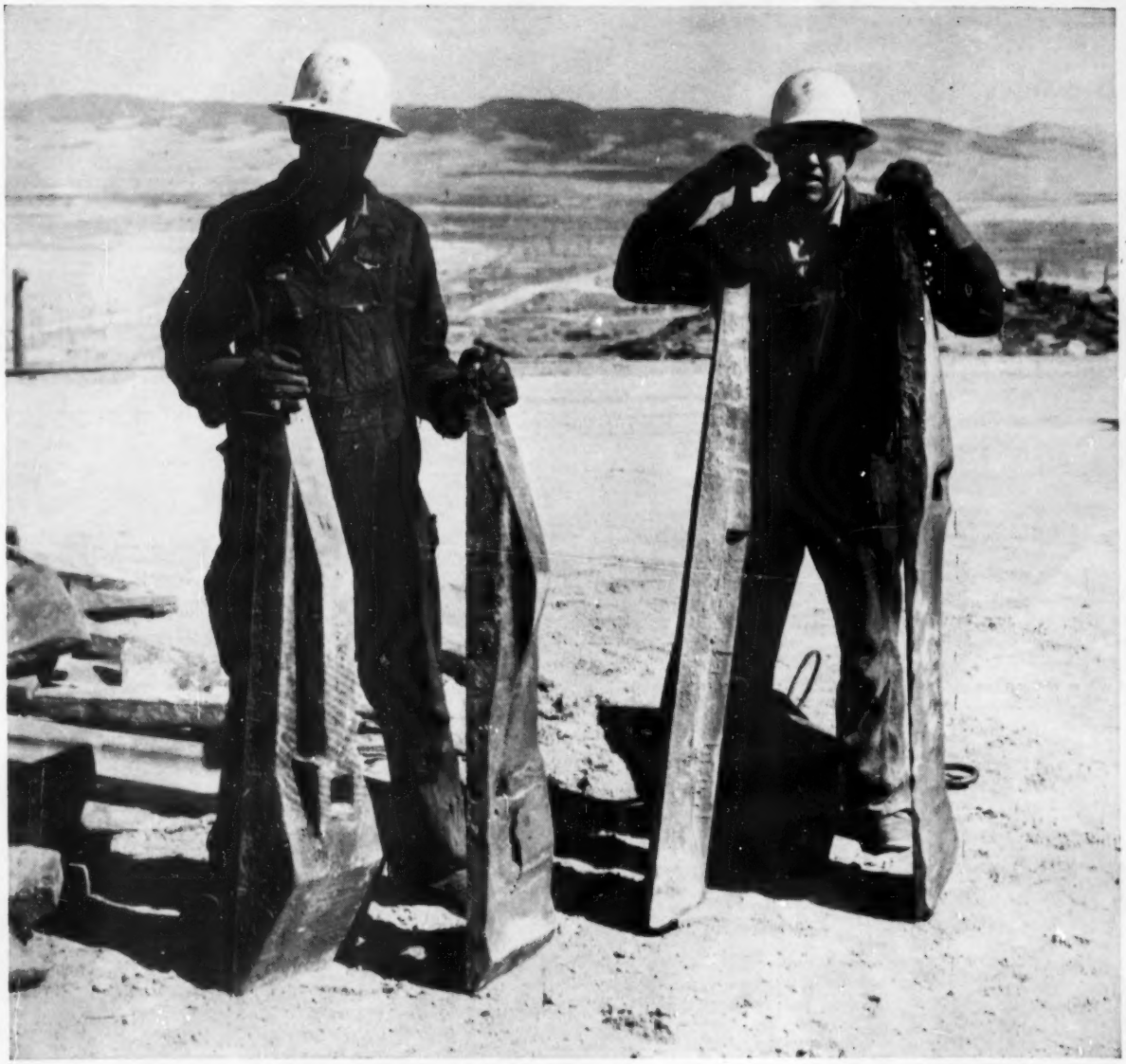
And the records prove that Marion 6 to 13-yard mining shovels are most impressive in day-in, day-out production, availability, maintenance costs, and operating costs.

If you're more interested in production than price; if you're interested in sustained profitable performance, our mining specialists would like to talk with you about job-proved facts.

Progress begins with digging MARION

MARION POWER SHOVEL COMPANY • Marion, Ohio

A Division of Universal Marion Corporation



In 20 Anaconda ball mills...

Ni-Hard liners are good to the last ¼ inch... cut mill downtime, cut mill costs

To save thousands of hours of downtime ...thousands of dollars in repair and replacement costs...that's why The Anaconda Company installed Ni-Hard* nickel-chromium-iron alloy liners in twenty ball mills grinding abrasive copper ore.

The proof is in the picture. The worn liner on the far right shows you how Ni-Hard liners keep their contour right down to the last fraction of an inch. That's because Ni-Hard liners not only have outstanding resistance to abrasive wear but also have a uniform wear rate so that you get higher efficiency and longer working life out of the design of your Ni-Hard liners.

Try a set of Ni-Hard liners in your mills. Just contact the Ni-Hard producing foundry in your area. They'll be glad to discuss the design characteristics best-suited for the liners in your mills, glad to give you further information on Ni-Hard liners and how they can help you cut mill-operating costs.

For further information on Ni-Hard iron feed spouts, pipe elbows, and many other parts where abrasion-resistance is required, just drop a note to Inco. We'll send you your free copy of the useful 58-page booklet, "Engineering Properties and Applications of Ni-Hard" and a list of Ni-Hard producing foundries.

**Registered Inco Trademark*

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street INCO New York 5, N. Y.

NI-HARD

NICKEL MAKES CASTINGS PERFORM BETTER LONGER

Pima Adds New Equipment for Westward Stripping and New Pit

Pima Mining Company has placed a new Marion 151 electric shovel with an 8-cubic yard bucket in operation at its Pima open pit in Arizona's Twin Buttes district. Eight new KW-Dart 55 T Diesel trucks are also being added to the Pima stripping fleet to extend the pit westward.

The photograph shows scrapers stripping alluvium on upper benches as the pit is extended west toward the Daisy shaft of Banner Mining Company. Start of gravel overburden stripping for the new pit, east and northeast, of the present pit is scheduled to begin about March 1962 with Pima's existing scraper fleet. Shovel and truck stripping of gravel may follow to determine cost comparison.

The mill extension which will raise capacity to 6,000 to 8,000 tons per day, depending on ore hardness, will be ready for operation in October 1963. Extension will be to the south of present mill. Crusher plant expansion will probably be ahead of mill expansion. First phase of the expansion is already underway with crews at work on shop and change room additions.

The new pit will not be a "tight" pit comparable with the present pit and is designed for all-truck haulage in contrast to the present narrow pit which has an inclined skip for hoisting ore and waste from three deep pockets. E. D. Spaulding is manager and Robert E. Thurmond, assistant manager.

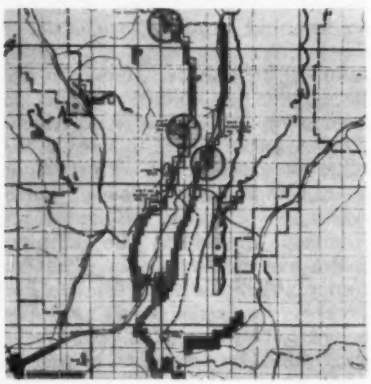
Getchell Reopens; Will FluoSolid Roast Refractory Gold Ore

Goldfield Consolidated Mines Company has reopened the Getchell gold mine at Golconda, Humboldt County, Nevada, and expects to spend $2,250,000 on new equipment and mill expansion. Plans call for open pit mining and milling a heretofor undeveloped gold ore body. Stripping has already started with newly purchased Euclid equipment including three S24 scrapers, one TC12 and one TC6 bulldozer and four 27-ton Diesel trucks.

The existing tungsten mill is to be modified and enlarged to handle 1,500 tons of gold ore per day. A Dorr-Oliver FluoSolids roaster is to be installed, and other facilities added to take advantage of automation and new ore processing techniques. After roasting the ore will be treated by conventional cyanide circuits. Since the highly refractory gold ore at Getchell contains arsenopyrite, it has been the cause of continual metallurgical trouble since the mine began operating in 1938. In the past, all attempts at using special reagents to increase gold recovery in the acid circuits have failed. However, with the new roasting procedure a smoother operation and a higher recovery is assured, according to Willis A. Swan, president of Getchell Mines, Inc.

Mill expansion is scheduled to be completed by April 1962, and will make Getchell the second largest gold mining operation in the United States—after Homestake Mining Company's operations in the Black Hills, South Dakota.

Gold mining was suspended at the 23,000-acre Getchell tract, in which Goldfield holds a 42.6 percent interest, in 1950. However, tungsten operations continued until 1956 when all activity at the property ceased.



International Minerals Will Develop Husky Oil's Phosphate Reserves in Southeastern Idaho

An agreement has been signed that allows up to five years for finalizing a joint plan to develop some 50,000,000 tons of phosphate reserves northeast of Georgetown, Idaho. The reserves, consisting of three leases, shown as 1, 2, and 3 on map, in the vicinity of Green Mountain, have been owned by Husky Oil Company for a number of years. In the event Husky decides not to enter the project, the agreement provides an equitable basis for sale of the properties to International Minerals & Chemical Corporation.

AERIAL VIEW of Lavender Pit mill shows pit and crusher (top left), and U. S. Route 80 winding under overhead belt conveyor going to the 12,000 ton per day concentrator.

How Electronics and Automation Increase Crushing Efficiency at Lavender Mill

John R. Bogert
Field Editor, Mining World

At Bisbee, Arizona, copper ore is moved swiftly from the Lavender pit through primary crushing to fine ore storage with the aid of several electronic marvels that are the pride of the local Phelps Dodge concentrating department.

As trucks dump ore into the primary crusher: (1) a photoelectric cell keeps count of the truck loads; (2) a power integrator visually records the amperage required for crushing; (3) another photoelectric cell assures a full pan feeder to save wear; (4) closed circuit television monitors coarse ore storage; and (5) an automatic tripper car evenly distributes ore in the fine ore storage bin. All of this is done smoothly, silently, automatically—with a minimum of care and maintenance.

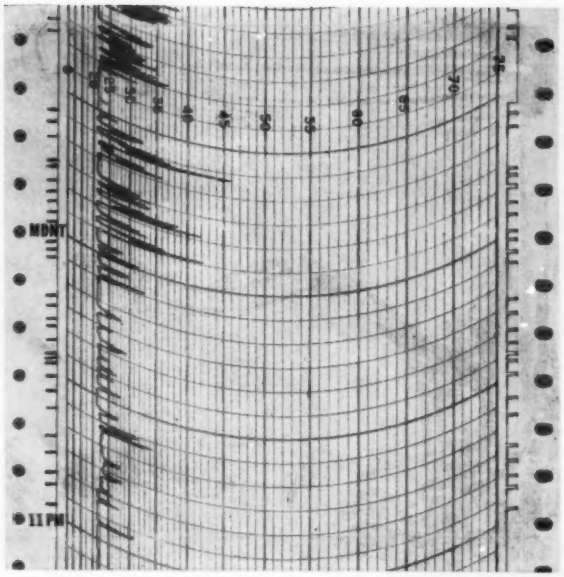
The results? Closer control of the crushing-storage circuit, real dollars and cents savings in power consumption and pan feeder wear and tear, reduction of jam-ups at conveyor transfer points and in storage bins, and assurance of a steady supply of fine ore to eight grinding circuits in the concentrator. Also the greatest benefit—the knowledge that operations are running at high efficiency with modern control equipment.

Chart Keeps Automatic Record

The primary crusher is located within the rim of the Lavender Pit. Visual traffic signals are used to control the 25 and 35 ton trucks which back and dump into the gyratory crusher from two opposite sides. With the red light on there is no backing and dumping. But trucks may back in and position on the yellow light; dump on the green light. If the traffic signal turns to red after a truck has backed in, a warning siren sounds, and the truck must drive out. While backing to the dump position, the beam of a photoelectric cell is cut, and the time spent by the truck in dumping is graphically recorded on a strip chart, located in the control sub-panel inside the crusher building. This automatic tally provides a constant, accurate record of truck-dumping activity at the crusher.

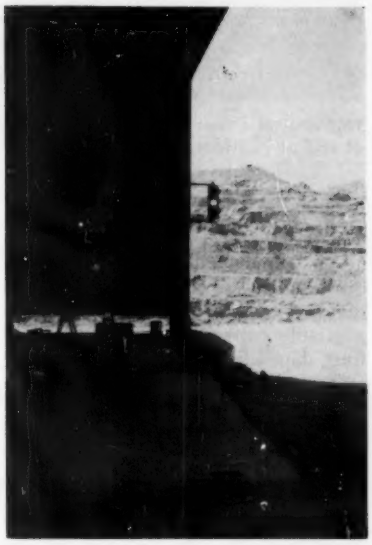
The strip chart also shows the amperage required to crush the ore to minus-5½-inches. The ore varies in hardness and size, so power consumption for crushing continually rises and falls. By using a power integrator connected to the same strip chart that tallies truck activity, the amperage needed for crushing is graphically recorded as a wavy ink line. Examination of the strip chart shows soft ore is crushed with only 25 to 30 amperes, while harder ore often requires over 45 amperes.

The minus-5½-inch discharge from the crusher goes directly onto two four-foot manganese steel pan feeders that handle a maximum of 750 tons per hour. In order to reduce wear on these feeders, provision has been made for a cushion of ore to remain on the feeders at all times. This is accomplished by use of another photoelectric cell with the light beam going across the feeder, which will only work when the light beam is broken. The broken beam indicates a two-foot cushion of ore is on the feeder. When the light beam is not broken, the feeder stops until ore comes from the crusher and breaks the beam. Over a period of time it



STRIP CHART record shows activity at crusher around midnight. Vertical column at right shows number of trucks and time spent dumping; left column marks each dump box raised; center shows amperage required for crushing.

PAN FEEDER loading under the primary crusher is controlled by a small photoelectric cell.



TRAFFIC signal at primary crusher shows Lavender Pit in background.

CHART at crusher tallies truck activity and amperage needed to crush ore.

has been found that this system reduces wear on the feeder pans by about 60 percent.

Ore from the pan feeders goes directly to a 48-inch inclined belt conveyor 975 feet long with a 219-foot lift. This belt travels at a speed of 440 feet per minute and carries a maximum of 1,500 tons per hour to coarse ore storage.

Television Watches Ore Storage

The 10,000-ton coarse ore storage pocket is alongside the concentrator building, and is covered with a dome-shaped corrugated steel roof for protection against the erratic rainfall of this section of Arizona. Ore discharge in the storage pocket is monitored by closed circuit television to prevent jam-ups and overflowing. The television camera is placed on a small platform high in the roof support girders, and is focused on the illuminated discharge end of the conveyor. The monitor viewer (television receiver) is in the control booth at the primary crusher building under the constant scrutiny of the operator. For cooling purposes an air blower continually plays on the television camera and keeps the lens free from dust.

Ore is drawn from the coarse ore storage pocket by two 48-inch manganese steel pan feeders, and discharged onto a 42-inch inclined belt conveyor 589 feet long with a 130-foot lift. This conveyor travels at a speed of 400 feet per minute and carries a maximum of 1,200 tons per hour. From this conveyor ore is transferred to a 54-inch belt (36 feet long) that routes the ore to either one or both sections of the secondary crushers. A metal detector is placed at the end of the 54-inch conveyor, and if actuated, stops the conveyors and pan feeders under the coarse ore storage pocket.

There are two parallel secondary crushing sections each consisting of: (1) a one-and-a-half-inch opening grizzly sloped 35°; (2) one seven-foot standard cone crusher with a one-and-a-half-inch opening; (3) four four-by-eight-foot rod deck screens with 5/16-inch openings; and (4) two seven-foot short head cone crushers with ¼-inch openings. The undersize from the grizzlies, along with the product from the standard crushers, feeds the 5/16-inch opening screens. Screen oversize is crushed in the short head crushers. This product joins the screen undersize on a 42-inch horizontal belt conveyor 92 feet long.

The crushed ore is then transferred to a 36-inch belt conveyor 315 feet long with a 94-foot lift. On this belt the ore is weighed in transit by a transportometer belt scale. The ore then moves over a short 14-foot-long transverse belt to a 36-inch, 284-foot-long horizontal conveyor running on top of the fine ore storage bin. Discharge of the ore from this belt is controlled by an automatic tripper car system that is fast, efficient, and reliable.

TELEVISION camera view of covered coarse ore storage bin at end of 975 foot long belt conveyor.

PICTURE from television camera is easily watched on screen at right by operator at the primary crusher.

Even Filling of Ore Bin Assured

The 9,000-ton fine ore storage bin at the concentrator is a single large bin of catenary construction with no dividers or baffle plates. It has an available capacity of 7,000 to 8,000 tons, depending on the moisture content of the ore. The eight ball mills in the concentrator draw ore from this one storage bin by pan feeders through 27 discharge gates—three mills are fed by four feeders each, and five mills by three feeders each. The purpose of the automatic tripper car system atop the fine ore storage bin is to keep the bin *evenly* filled along its entire length so that all the discharge gates at the bottom are continually covered with ore. Thus the tripper car moves back and forth over the top of the bin filling it at a rate of 800 to 1,000 tons per hour.

Operation of the tripper car is either manual or automatically controlled through adjustable limit switches. The motor is equipped with a solenoid brake for reversing. The system is so arranged that the tripper car can discharge in any section of the bin and remain in that position until that section is filled, or continually traverse the entire length of the bin filling as it goes. Magnetic proximity switches are used to control the position of the tripper car.

At eight places inside the storage bin, corresponding to each line of draw-off feeders for the eight ball mills, three transistorized probe switches have been placed to measure ore levels. At each point the three probes of different lengths are suspended on pipes from the roof of the bin. One pipe goes to just above the bottom of the bin, one to the mid-point, and one short pipe ends near the top of the bin. As ore fills that particular section of the bin, each of the probes is successively touched by the growing pile. As soon as the probe is covered by ore, control lights on a master panel (yellow, green, and red) are actuated by the three depth defining probes. When the bottom probe is in contact with ore the yellow light is on, when the mid probe is touched the green light goes on, and finally when ore reaches the short probe near the top of the storage bin the red light goes on.

PANEL controls remote operation of tripper car system atop storage bin.

There are eight groups of these yellow-green-red lights on the control panel corresponding to the probes placed over the eight feed points. These lights are continually going on and off as ore is being added at the top of the bin, and (at the same time) being drawn off at the bottom.

Should any section of the storage bin become too full in the course of normal operation, a probe at the end of the tripper car chute sounds a warning siren and the entire system is shut off. Likewise, probes are located in all feed boxes at conveyor transfer points. At the first sign of a jam-up the entire conveyor system, is shut down back to the coarse ore storage pocket. Once the equipment is shut down it cannot be restarted until someone goes to the point where the trouble occurred, makes a visual examination, and resets the circuit. Other safeguards include belt misalignment switches and zero speed switches.

The tripper car can be controlled manually through a small switch box mounted on the side of the car, or from the master control panel located in the grinding section of the concentrator. The control panel stands over six feet high and contains all the vacuum tubes, switches, relays, etc., necessary for remote control of the tripper car and conveyor belts. The entire equipment layout, its status (whether running or shut down), as well as the lights indicating the level of ore in the various sections of the storage bin has

continued on page 48

by Karsten A. Rist

Mr. Rist is long range procedures engineer for Climax Molybdenum Company with headquarters at Climax, Colorado.

SURFACE facilities for Storke level at Climax mine includes crusher buildings and storage area (center left), connected by covered conveyor system going to mill (out of picture to right). Mine portal is near changehouse (center right).

Computer Simulation for Solution of a Mine Transportation Problem

In recent months the mining industry has devoted a great deal of attention to computers and their utilization for solving technical and managerial problems. Examples of how survey calculations and ore reserve calculations may be accomplished have been published. It has also been shown how linear programming may be used to solve mixing and transportation problems. This article gives an example of how a Monte Carlo model may be constructed and how it can be used to answer certain engineering questions. The name Monte Carlo model stems from the fact that the model, like certain games of chance, is operated by the use of random numbers. In the completion of the project I am indebted to the Management Engineering Department and the Industrial Engineering Department in Climax as well as to the computer staff of Kaman Nuclear in Colorado Springs, Colorado.

Problem of Production Capacity

The problem which confronted the Management Engineering Department at Climax was to determine the productive capacity of the adit and crusher on the Storke level. Figure No. 1 gives a schematic picture of the conditions on the Storke level. The round trip of one train on the Storke level consists of four phases:

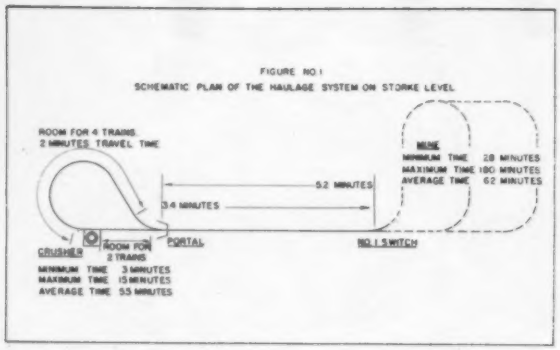
1. Entering the mine through the portal and proceeding to No. 1 Switch.
2. Loading and travel starting from No. 1 Switch and returning to No. 1 Switch inside the mine.
3. Leaving the mine through the portal and proceeding to the crusher.
4. Dumping the train load into the crusher and looping back to the portal.

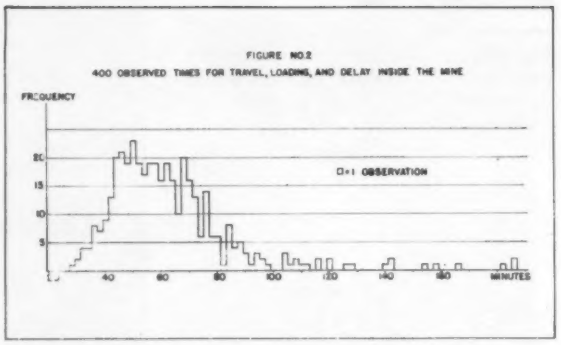
For operation Nos. 1 and 3 the same "service facility" (i.e., the tunnel) has to be used. The service times are constants. Operation No. 2 can take from 28 to 190 minutes with an average time of 63 minutes. The wide range of possible loading times reflects various delays, breakdowns, and interference of other operations.

For purposes of the study the assumption could be made that a sufficient number of loading places would be available to load any number of trains which could be routed through the tunnel and crusher.

No matter how many trains are used on the level the model will reflect the loading delay times which occur under present conditions. Operation No. 4 takes from 3 to 15 minutes with an average time of 5.5 minutes. Only one train at a time can be unloaded.

The first approach to determining the capacity of the crusher would be to divide 5.5 into the total number of minutes per shift. However, it





would be questionable whether a sufficient number of trains could be sent through the tunnel in suitable intervals to keep the crusher busy at all times. One train takes 8.6 minutes inside the tunnel during one round trip, as is shown in Figure No. 1. Two trains following each other at a distance of 1,000 feet would occupy the tunnel for 11.4 minutes, or for only 5.7 minutes per train. Nevertheless a decision to send trains only in pairs through the tunnel would be mipractical because of the waiting time which would result for many trains. Any optimal pattern for sending trains into and out of the mine would be interrupted by the unpredictable individual loading time for each train. Considering these theoretical difficulties it is apparent that no simple answer can be given to the question of the capacity of the system.

In a situation of this nature one could consider building a little scale model of the haulage system, supplying this model with an increasing number of trains, and observing how well the system can handle the load. In the case at hand the model was built out of numbers in the memory of a computer, but its performance characteristics were very similar to those of a physical model.

How Mathematical Model Is Made

In order to describe the round trip of one train in the memory of the computer we establish three check stations or waiting positions in the system:

WP = Waiting position of a train at the portal, ready to enter the mine.

WS = Waiting position of a train at No. 1 Switch ready to leave the mine.

WC = Waiting position of a train at the crusher, ready to unload.

The digits which the waiting positions contain will represent the number of trains waiting at these locations in our fictitious mine. The waiting positons correspond to certain locations in the memory of the computer. While a train is moving between the waiting positions its future arrival at the next stop will be recorded in three time schedules:

AWP = Schedule of arrivals at the portal, corresponding to WP.

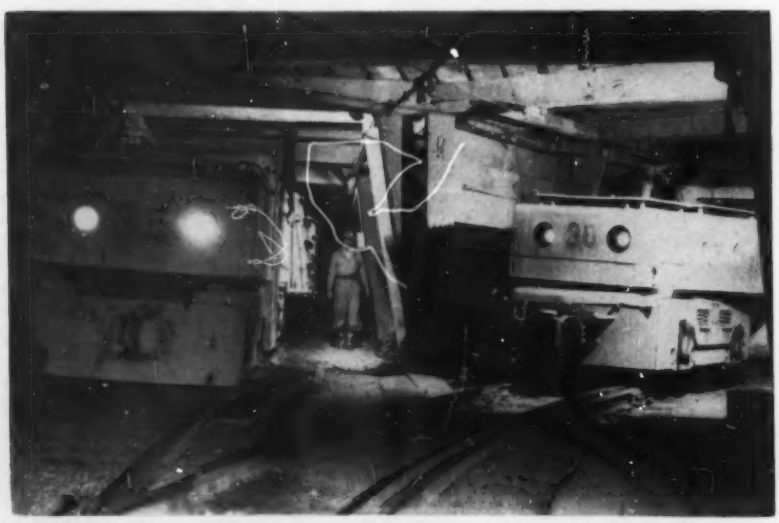
AWS = Schedule of arrivals at No. 1 Switch, corresponding to WS.

AWC = Schedule of arrivals at the crusher, corresponding to WC.

The position of the trains will be considered once every minute and all necessary decisions will be made. A time count, TC, which is set to zero at the beginning of the shift is being advanced by one for each interrogation. When the time count reached 420 the program is terminated and the computer prints the results. At that point 420 minutes of operation have been simulated. 420 minutes or seven hours are considered actual working time per shift underground.

While the waiting positions record the location of stopped trains the time schedules keep track of moving trains. The time schedules consist of one memory position of the computer for each minute of a shift. At the beginning of an interrogation the computer will check the three time schedules for the minute which is given by the magnitude of TC. If the arrival of a train had been recorded for this minute the train will be moved into the appropriate waiting position. The computer will then investigate whether the waiting train can be sent on to the next waiting position in sequence. If this is possible the arrival at the next waiting position will be computed and a "1" is inserted into the appropriate time schedule in the position which corresponds to the minute of arrival. The computer then proceeds to the next interrogation.

If for instance a train enters the crusher at minute 100 and is assigned a crushing time of six minutes the train will leave the crusher



ORE TRAIN waits at No. 1 switch as second train highballs to portal in average time of 5.2 minutes. Computer scheduling prevents these types of delays.

FIGURE NO.3

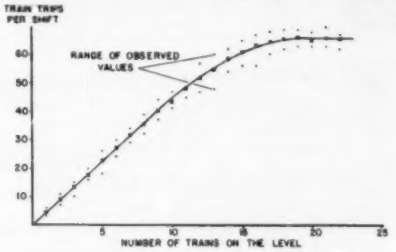
SAMPLE OF THE COMPUTER OUTPUT.

NUMBER OF TRAINS = 10
NUMBER OF TRAINS OUTSIDE = 03

WAITING TIMES				TOTAL	OCCUPIED TIMES	
PORTAL	CRUSHER	SWITCH	TOTAL	TRAINS	PORTAL	CRUSHER
91	89	85	265	43	243	234
83	95	86	264	42	235	237
72	82	67	221	46	268	242
71	66	62	199	41	242	227
78	86	59	223	43	243	246
100	74	74	248	42	231	216
82	83	80	245	44	262	245
132	98	69	299	47	268	247
145	75	76	296	45	263	249
88	72	65	225	41	242	228
68	82	58	208	43	238	225
97	95	83	275	44	256	248
123	89	86	278	43	253	236
125	79	66	270	41	243	225
98	88	80	269	46	267	234
96	89	81	266	41	235	215
98	121	111	330	43	253	238
116	72	68	256	44	253	218
92	63	104	259	45	264	223
115	85	131	331	43	240	225

FIGURE NO.4

TRAIN TRIPS PER SHIFT DEPENDING ON THE NUMBER OF TRAINS ON THE LEVEL.



at minute 106. The minutes later at minute 108, after traveling through the crusher loop, the train arrives back at the portal. We therefore, insert a "1" into AWP in the memory position which corresponds to minute 108. As TC is being incremented it will become equal to 108 and at this time the train will be moved into WP.

Whenever a train is being sent into the mine it is necessary to determine which loading time should be assigned to this train. Figure No. 2 shows 400 loading times which were observed underground. A list of these 400 times has been inserted into the memory of the computer. The computer is then made to generate a random number between 0 and 400. The random number is converted into the address of one of the 400 loading times. The address of a position in the computer memory is a number which identifies this position like a house number identifies a house. In the memory position identified by the address the computer finds the stored information. The computer can now extract this loading time and assign it to the train which has just been considered. Each loading time has the same chance of being selected. Loading times of about 55 minutes will occur more frequently because they are contained in the listing more often. However, at irregular intervals very high times will be selected, thus representing the irregular delays and breakdowns underground by selecting loading times at random a much higher degree of realism can be achieved than by using an average time.

The same system is being used to select crushing times from a list of actually observed crushing times.

It is necessary to record the time for which the crusher will be occupied whenever a train moves into the crusher. This is accomplished by a special time count COT (Crusher Occupied Time). COT = TC + crushing time when a train enters a crusher. As long as COT > TC, the crusher is considered occupied. The same principle is being applied when a train enters the tunnel. At that time a tunnel occupied time is computed. In addition it is necessary to record the direction in which the train is going. This is accomplished by another count, "IO". A "1" in IO represents the fact that a train is going into the mine, a 2 records a train is moving out of the mine. In order to provide for the possibility of sending more than one train at a time through the tunnel it is necessary to provide for 1,000 feet of distance between the trains. A train interval count, TIC, is set to the time in minutes which it takes a train to travel 1,000 feet, whenever a train enters the tunnel from either side. Each minute TIC is diminished by one. The next train may then only enter the tunnel if TIC $\leq$ 0.

We have now discussed the various mechanisms which will provide for the correct movement of trains through the system.

Rules For Making Decisions

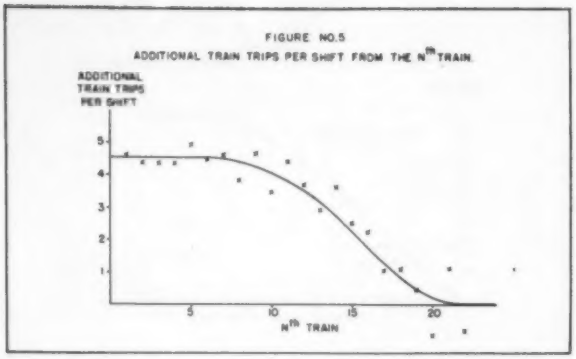
Each minute after the trains have been moved from the arrival schedules into the waiting positions it has to be decided whether a train should enter or leave the portal. A train can be sent into the mine if the following conditions are fulfilled:

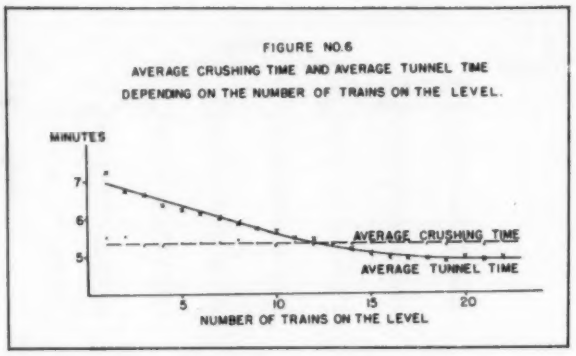
1) The portal is empty or a train is moving in.
2) TIC $\leq$ 0, i.e. the previous train has a head start of 1,000 feet.
3) WP $\geq$ 1, there is at least one train waiting at the portal.

A train can be sent to the crusher if another set of conditions is given:

1) The portal is empty or a train is moving out.
2) There are not more than two trains before the crusher including the train or trains in the tunnel.
3) There are not more than five trains in the crusher loop and the portal. Condition Nos. 2 and 3 are necessary to keep the switch at the portal free (Figure No. 1).
4) TIC $\leq$ 0, i.e., the previous train has a head start of

DUMPING at crusher and looping back to mine portal takes an average time of 5.5 minutes. Keeping crusher busy at all times requires split-second scheduling.





1,000 feet.

5) WS $\geq$ 1, i.e., there is at least one train waiting at No. 1 Switch.

If the portal is empty and trains are waiting at both ends the side which has the larger number of trains waiting will be serviced first. If an equal number of trains happens to be waiting at both ends of the tunnel the trains which wait at the portal will be sent in first since this operation takes less time than sending trains out.

After flow charts for the model had been set up to reflect all the conditions which have been described above, the model was coded in SPS (Symbolic Programming System language) for an IBM 1620 computer. The program was set up to make the computer accept two new input values if a certain program switch was set. The new input data were the number of trains on the level and the number of trains which are outside the mine at the beginning of the shift.

The reason for the second input value was to determine whether there would be a tendency for trains which entered the mine in succession at the beginning of the shift to remain grouped throughout the shift. At the beginning of the program the first of the n trains inside the mine was assumed to have passed $\frac{n}{n}$ parts of its loading time, the second $\frac{n-1}{n}$, the third $\frac{n-2}{n}$ and so on. If three trains with the randomly selected loading times of 56, 60, and 81 minutes were in the mine at shift begin they would have passed 56, 40, and 27 minutes of their loading times. The first train would be ready to leave the mine immediately, the second at minute 20, and the third at minute 54. The output of the program contained the accumulated train waiting time at the three waiting positions (Σ WP, ΣWS, Σ WC, computed cumulative throughout the shift at the end of each minute), the total train waiting time, the number of trains which left the portal during the shift, and the number of minutes for which the crusher and the portal were occupied.

The program contained about 400 instructions. It took about 1.5 hours to translate it into machine language and about 6.5 hours to debug the code. The computer simulated one shift operation in about 30 seconds.

Monte Carlo Method Offers Advantages to Mining Industry

A sample of the computer output is reproduced in tabular form in Figure No. 3. Ten trains were on the level, three of which were outside the mine at the beginning of the shift. The 20 trial shift operations show a total train waiting time per shift which varies from 199 to 331 minutes. 41 to 47 trains left the portal during one shift. The averages of about 40 trials for each number of trains have been plotted in Figure No. 4. The first derivative of the curve in Figure No. 4 is shown in Figure No. 5. Here the additional number of train trips which each additional train on the level will permit has been plotted. From Figure No. 4 or Figure No. 5 the mounting cost of haulage as the capacity of the system is being approached can easily be determined. The fact that all trains will always take the same average time to dump their load can easily be verified from the last column of the computer output. However, if the total number of trains which left the portal during one shift is divided into the time for which the portal was occupied the result decreases as the number of train trips per shift increases. The decrease of the average tunnel time is due to the fact that trains are sent in pairs more often when many trains are on the level. A series of values for the average crushing time and for the average tunnel time has been plotted in Figure No. 6. It can be seen that with train number 13 the crusher rather than the portal becomes the bottleneck of the operation, since for 13 or more trains the average crushing time exceeds the average tunnel time. Experimentation with varying number of trains outside the mine at the beginning of the shift showed that the loading times for the trains are sufficiently dispersed to avoid the possibility that all trains which entered the mine in succession will also arrive at No. 1 Switch in series.

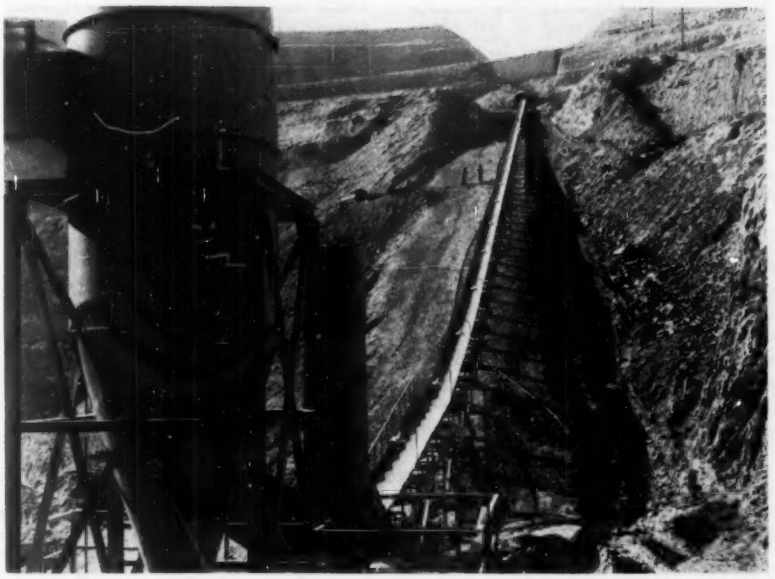
The reader can easily imagine that the model of the tunnel and crusher operation can be used to test various decision rules of how the traffic in the tunnel should be directed. The effects of changes in the system like additional waiting positions ahead of the crusher, a second portal, or improved crushing facilities can easily be evaluated.

It appears that a Monte Carlo method as described in this article has certain advantages which make it especially useful to the mining industry. It is easy to inject into the model factors which will simulate the unpredictable delays and breakdowns which are common to many mining operations. Only a minimum of simplifying assumptions has to be made when the model is being set up. For instance, the distribution curves for various operation times need not be substituted by idealized mathematical expressions, but rather the originally observed values can be fitted into the model. The concepts of the model can easily be explained to the operating personnel and the answers which were generated gain in acceptability because they are rather removed from theoretical considerations. END.

AERIAL VIEW of open pit borate mine and processing plants of U. S. Borax & Chemical Corporation at Boron, California. Pit is currently 310 feet deep, 2,000 feet long, with the new conveyor system visible in left center foreground.

A Conveyor Takes Over at Boron

At the time of planning in 1955, a belt haulage system was envisioned by U.S. Borax management to be built when pit development made the project feasible. Today, the system is a reality, and a new conveyor installation carries borates to the top of the Boron pit fast and efficiently.



BELT is 1,300 feet long up 18° slope out of pit. Tunnel at top is midway point on belt. Cyclone at left is part of dust collecting system at crusher.

A modern, advanced design conveyor belt is now bringing ore out of the United States Borax & Chemical Corporation's open pit mine at Boron, California. This efficient belt haulage system, equipped with the newest features in the continuous conveyor field, carries sodium borate ore 1,300 feet up an 18° slope for a vertical lift of 320 feet.

The immediate savings have been impressive: truck haulage costs have been halved, and mine production increased since the conveyor transports as much ore in three hours as trucks did in eight. The long range benefits of the system include reduction of overall mining costs, a substantial saving in depreciation schedules, increased flexibility in meeting ore demands, and an improvement of haulage safety by reducing manhours of exposure to operation of trucks on adverse grades.

The shallow Boron ore body is approximately two miles long, one half mile wide, dips to the southeast, and varies from 137 feet to 1,000 feet deep. Until 1957 mining was by several underground methods. These included shrinkage stoping; then room and pillar with drilling, blasting, and slusher stopes; and finally room and pillar with Joy continuous miners. At one time block caving was attempted. Although these methods gave low-

HEADFRAME at edge of pit contains drive machinery to power conveyor belt. Combination of three 200-horsepower motors gives belt speed of 600 feet a minute.

cost underground production, pillars of ore had to be left behind for support of the back. In 1955, in order to increase production, recover virtually 100 percent of the ore, and achieve even lower mining costs per ton of ore extracted, management wisely decided to convert operations from underground mining to open pit.

From the beginning of pit planning in 1954 a combined truck-conveyor system was considered best for hauling ore. However, a final decision was reached only after giving due consideration to a continuing 100 percent truck haulage system and a skip hoist.

Studies comparing the proposed conveyor system with a skip hoist showed that within a certain range of operating conditions, the cost per ton-mile for conveyor haulage was definitely less than by skip hoist. This was principally because a skip installation would require more operating personnel and maintenance.

Studies comparing a 100-percent truck haulage system versus the proposed conveyor system were also enlightening. Engineers estimated ore requirements for a 15-year period. From calculated cycle times and truck requirements, a detailed equipment schedule was made for both competitive methods. It became apparent that the belt conveyor reduced the truck cycle time by an important amount as seen in Table No. 1. Using basic scheduling data, plus equipment and labor charging rates, operating costs for the two schemes were determined. A comparison of these operating costs over a 15-year period showed a substantial saving in favor of the belt conveyor system (Table No. 2). Likewise, depreciation schedules were made, and again, substantial savings were realized in conveyor haulage. Capital costs for the two competitive systems were also made, and over the same period were close. However, 60 percent of the capital cost in the conveyor system is for acquisition and replacement of trucks, and only 40 percent is for the installation and replacement of the conveyor and crusher. The summaries of the operating, depreciation, and capital costs were finally placed in a profitability index, and the net rate of return after taxes over a 15-year period for the conveyor system was seen to produce a return on investment in the range of 20 percent.

The continuing investigation to find the best haulage system eventually took a team of U. S. Borax engineers to Europe. Here, in German and Italian mines, they checked the problems and advantages of several conveyor installations.

With such overwhelming evidence, plus the fact that the Boron ore body is essentially horizontal in extension (with relatively shallow depth), it was easy to see that an extendable conveyor system would provide the best long-range solution at lowest possible cost. With an expanding pit going in only one direction a belt conveyor could easily be increased in length, thereby offering the most practical answer to economic ore haulage consistent with good mining practice. Management's decision to go ahead with the conveyor system was the only conclusion to be reached after such an exhaustive study of alternative methods.

Stripping and development of the Boron open pit got underway in 1955. Trucks were used to haul the ore out of the pit to a crusher located on the surface.

By 1960 the pit was fully developed, and ore was being transported to the surface along a two-and-a-half mile spiral haulage road

100 Percent Truck System Versus Conveyor-Truck System[1]

TABLE NO. 1
Truck Cycle Time

Fiscal Year Ending	Difference in Elevation		Adverse Grade Distance		Total Cycle Time		Ratio of Trucks Required	
	100% Truck	Conveyor & Truck	100% Truck	Conveyor & Truck	100% Truck	Conveyor & Truck	100% Truck	Conveyor & Truck
1961	150	70	2,150	1,000	17.90	8.29	1.00	0.43
1962	200	120	2,860	1,710	19.16	9.56	1.07	0.50
1963	230	150	3,300	2,142	19.95	10.32	1.14	0.64
1964	270	190	3,860	2,710	20.93	11.34	1.28	0.72
1965					21.33	12.03	1.43	0.86
1966					21.80	12.78	1.57	0.93
1967			Interpolated		22.22	13.44	1.71	1.07
1968					22.73	13.96	1.93	1.21
1969					23.19	14.26	2.07	1.29
1970					23.67	14.54	2.28	1.43
1971	400	320	5,710	4,570	24.23	14.65	2.50	1.57
1972					23.12	13.91	2.57	1.57
1973			Interpolated		22.16	13.20	2.64	1.57
1974					21.28	12.50	2.78	1.64
1975	250	170	3,570	2,428	20.42	11.79	2.86	1.64

TABLE NO. 2
Operating Schedule

Ending Fiscal Year	Supervision Ratio		Shovel Ratio		Truck Ratio		Tractor Ratio		Water Truck Ratio		Grader Ratio		Crusher Ratio	
	100% Truck	Conveyor & Truck	100% Truck	Conveyor & Truck	100% Truck	Conveyor & Truck	100% Truck	Conveyor & Truck	100% Truck	Conveyor & Truck	100% Truck	Conveyor & Truck	100% Truck	Conveyor & Truck
1961	1.00	0.50	1.00	1.00	1.00	0.43	1.00	0.67	1.00	0.50	1.00	0.50	1.00	0.50
1962	1.00	0.50	1.00	1.00	1.07	0.50	1.00	0.67	1.00	0.50	1.00	0.50	1.00	0.50
1963	1.00	0.50	1.00	1.00	1.14	0.64	1.00	0.67	1.00	0.50	1.00	0.50	1.00	0.50
1964	1.00	0.50	1.00	1.00	1.29	0.72	1.00	0.67	1.00	0.50	1.00	0.50	1.00	0.50
1965	1.00	0.50	1.00	1.00	1.43	0.86	1.00	0.67	1.00	0.50	1.00	0.50	1.00	0.50
1966	1.00	1.00	1.33	1.33	1.57	0.93	1.33	1.33	1.50	1.00	1.50	1.00	1.00	1.00
1967	1.00	1.00	1.33	1.33	1.72	1.07	1.33	1.33	1.50	1.00	1.50	1.00	1.00	1.00
1968	1.00	1.00	1.33	1.33	1.93	1.21	1.33	1.33	1.50	1.00	1.50	1.00	1.00	1.00
1969	1.00	1.00	1.33	1.33	2.07	1.29	1.33	1.33	1.50	1.00	1.50	1.00	1.00	1.00
1970	1.00	1.00	1.33	1.33	2.29	1.43	1.33	1.33	1.50	1.50	1.00	1.50	1.00	1.00
1971	1.50	1.00	1.67	1.67	2.72	1.57	2.00	1.33	2.50	1.50	2.50	1.50	1.50	1.00
1972	1.50	1.00	1.67	1.67	2.79	1.57	2.00	1.33	2.50	1.50	2.50	1.50	1.50	1.00
1973	1.50	1.00	2.00	2.00	2.86	1.57	2.00	1.33	3.00	2.00	3.00	2.00	1.50	1.00
1974	1.50	1.00	2.00	2.00	2.93	1.64	2.00	1.33	3.00	2.00	3.00	2.00	1.50	1.00
1975	1.50	1.00	2.00	2.00	3.00	1.64	2.00	1.33	3.00	2.00	3.00	2.00	1.50	1.00

1. The base is equal to one, and the current fiscal year (1960-1961) equipment requirements are also equal to one.

—a truck trip requiring about nine minutes. During the four year period of pit development, over 250 feet of overburden was stripped away, slope stability tested, and the barren footwall of the ore body exposed.

Pit Ready For Conveyor System

Construction was begun on the conveyor system in March 1960. The U. S. Borax engineering department, in cooperation with the Boron mining department, designed the equipment which was built by Stephens-Adamson Manufacturing Company and erected by Amercon of Los Angeles, California.

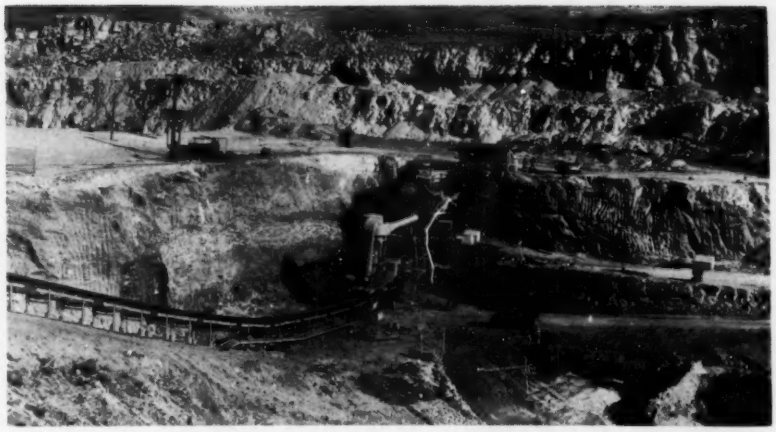
The new haulage system begins at the crusher station located in the bottom of the pit on the barren footwall of the ore body. Here, trucks dump run-of-mine ore into a 90-ton receiving bin. At the bottom of the bin a 72-inch wide pan feeder moves the material into a specially designed 91,000-pound hammer mill having a 54- by 70-inch opening. This unit is driven by a 600 horespower induction motor so that the hammers revolve at a speed of some 500 revolutions per minute.

Of the ore crushed by the hammer mill, 85 percent is minus-2-inch and the remainder minus-3-inch.

When crushed, the ore is discharged onto a 60-inch wide belt where tramp iron is caught by a magnetic separator. The ore is then fed onto the main slope conveyor. Dust is controlled with a 25,000 cubic feet per minute cyclone-type collecting system.

The main slope conveyor belt is of five-ply nylon-rayon construction, 42 inches wide and 7/8 inch thick. It is built to withstand tensions up to 44,000 pounds. Safety features include: limiting switches if the belt gets out of line; safety cord on one side which will immediately stop the belt when pulled by inspection men; a belt penetration device which shuts off the drives automatically when a piece of material penetrates the belt and extends through more than a quarter of an inch; and a centrifugal switch that stops drive if the belt slips on head pulley.

The conveyor framework is made up of a series of individual, unitized sections 17 feet long rather than one continuous support. This is an experimental attempt to develop a suitable design for possible application of belt conveyors to overburden stripping. Each 17-foot section contains five carrying idlers and two return idlers of rubber roll design. The return idlers tilt 2° in the direction of the belt run, and slope 10° toward the center.



CRUSHER STATION located on barren footwall of ore body can be relocated if conveyor system is extended. Crusher operator controls system with help of television.

Special Troughing For More Ore

Following standards used in German brown coal mines, troughing idlers are angled at 30° rather than the 20° so common in the United States. This steeper trough permits better cross-sectional loading on the belt, less material spillage, and permits 27 percent more material to move up the conveyor per hour.

In order to maintain the 18° slope over the 1,300 foot distance of the conveyor, it was necessary to cut through the main haul road which spirals into the pit. Traffic was diverted on the road, a trench dug, and a 10-foot diameter corrugated iron tunnel placed in the excavation. This tunnel is 115 feet long and about half way up the incline. The tunnel was installed by Armco and backfilled by U. S. Borax after installation. It is 35 feet below the present roadbed on the down-slope side, and five feet under the roadbed on the up-slope side.

At the edge of the pit the head section of the conveyor contains the drive machinery to power the belt. Primary drive atop the headframe is a 42-inch diameter head pulley connected to two right-angle, 58 revolutions-per-minute gear reducers. These in turn are driven through a coupling by two 200-horsepower motors. A third 200-horse-power motor supplies power to a secondary drive on the snub pulley. This power combination gives a belt speed of 600 feet per minute.

To prevent the belt from rolling back, two holdbacks have been mounted on the primary drive shaft and one on the secondary drive shaft. Thrustor brakes have been installed between the reducer input shaft and the eddy-current coupling output shaft.

Belt tension is controlled by an automatic electric take-up which applies proper tension on demand. This is an advance over conventional gravity type take-ups, and was designed by the U. S. Borax project engineering group. It operates with a constantly running 30 horsepower electric motor coupled to an eddy-current clutch and solenoids. This delivers a pre-set torque accuating a winch which pulls a belt tensioning device. The tension on the belt is programmed to coincide with the starting sequence of the main conveyor drive motors.

Television Helps Pit Operator

At the discharge end of the conveyor the crushed sodium borate ore falls against a splash plate and onto a wobbler feeder. The minus-3-inch material immediately falls through the bars onto a 42-inch wide stacker conveyor belt, forming a cushion for the coarser ore following. This stacker conveyor then carries the ore to the stockpile—the end of the line.

The entire system from truck dumping point in the pit through to the ore stockpile is completely automatic, and operated by only one man located in a control office alongside the pit crusher. Closed circuit television cameras give this operator complete control over the entire system. One camera is installed atop a high post overlooking the stockpile, giving the operator a clear view so that he can move the stacker by remote control. A second camera is zeroed-in on the main conveyor transfer point so that any plug-up can be readily spotted.

The United States Borax & Chemical Corporation can indeed be proud of its new conveyor system which is one of the most modern in the country, and ahead of its time in design and construction. END

DEEP DRILLING at North Broken Hill Limited is inspected by convention delegates. Note the special trussing on the derrick legs. Sixty foot pulls are routine.

Australia

Broken Hill Diamond Drill Symposium

How to Drill

Lectures, discussions, and drill site visits were all on the agenda for delegates to the recent Symposium on Diamond Drilling of the Australasian Institute of Mining and Metallurgy at Broken Hill, New South Wales, Australia.

Deep drilling attracted greatest interest because of the deep holes recently completed and now being drilled at the north and south ends of the famous Broken Hill lead-silver-zinc lode.

Deep drilling at the north end of the lode means a vertical hole 5,200 feet deep with a final deflection projected to 7,200 feet. At the south end two inclined holes have recently been completed to a final depth of 6,402 feet (started at an angle of minus-82°) and 5,608 feet at minus-72°. The first hole flattened to 36° at final depth and the second to 28°.

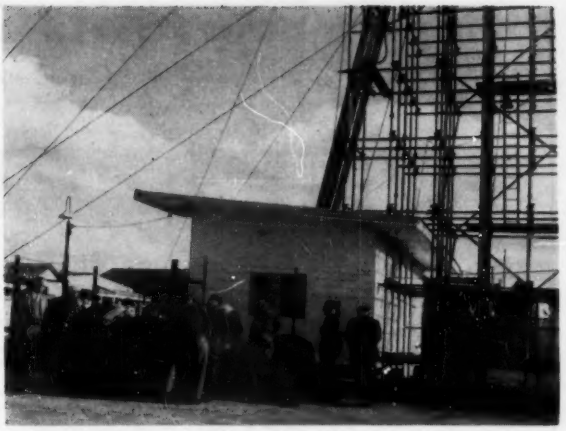
Deep Drilling Problems

J. D. Copley, senior mining engineer, and S. C. Jones, diamond drill foreman, Broken Hill South Limited presented a paper on South's experiences in drilling the two deep holes. The first was cased (BX) to a depth of 370 feet; the second to 1,300 feet. Both used BX to final depths. Electrically-powered drills were used.

Their summary of deep drilling problems is, "Troubles were caused mainly by the heavy weight of rods. Experience with the drill, the capacity of which was rated at 5,000 feet, showed that:

"1. The use of a double purchase hoist rope was essential below 5,000 feet and was well worthwhile earlier in the hole (the depth depending on

NORTH BROKEN HILL's F. 150 diamond drill gets a close inspection. Guide, J. C. Lissiman, is third from right.



TUBULAR STEEL scaffolding is used for Broken Hill South Limited's Lane Lane hole. Sound proof building houses drill.

Holes More Than 5,000 Feet Deep

the steepness of the hole) in the interests of maintenance on machines and ropes.

2. Careful maintenance of the rod string was essential to insure maximum water flow at the bit with a minimum pump pressure and led to safe and economical drilling.

3. Wide kerf bits offered a valuable counter to vibration which adversely affected the length of barrel run. BW rods were of negligible advantage over B rods, perhaps because the factors of rod section and the strength properties of alloy steel combined to produce a critical effect on the BX holes.

4. Providing a sufficient number of holes beyond 5,000 feet were contemplated, serious consideration of a separate and higher capacity hoisting unit would be warranted."

Because Broken Hill South is considering holes to 8,000 feet the senior draftsman, V. Grudzinskas, had made a study of hoist performance and arrived at the following conclusions: A 120 horsepower hoist would not be warranted to drill holes shallower than 4,000 feet. Deep holes listed above used a 60 horsepower. From 4,000 to 6,000 feet it could be used to advantage if enough holes were to be drilled to justify its initial cost.

The history of a deep, 4,353-foot, underground hole started at minus 67°, and bottoming at 5.5°, at the South mine was reported by J. D. Copley. The first 2,663 feet was BX to and through 30 feet of sericite schist which caved badly. With great difficulty AX casing was placed from 2,540 to 2,644 feet and cemented. The hole was finished with AX equipment. From 3,300 to 3,600 feet, six AX bit shanks were broken. These were of 28 tons quality steel. From 3,900 to 4,533 feet, five more bits were lost in the hole due to failure at bit crown or at the reamer to barrel connection. Several bits showed definite evidence of overheating.

As soon as problems developed, counter measures were taken to overcome them. Steel quality in bits was raised from 28 to 40 tons. Bit waterways were increased from two to four. Copper washers were replaced by wicking at rod joints with careful supervision to insure watertight joints. After lowering the drill string to the bottom to start a new run it was mandatory to have a clear water return before starting to drill.

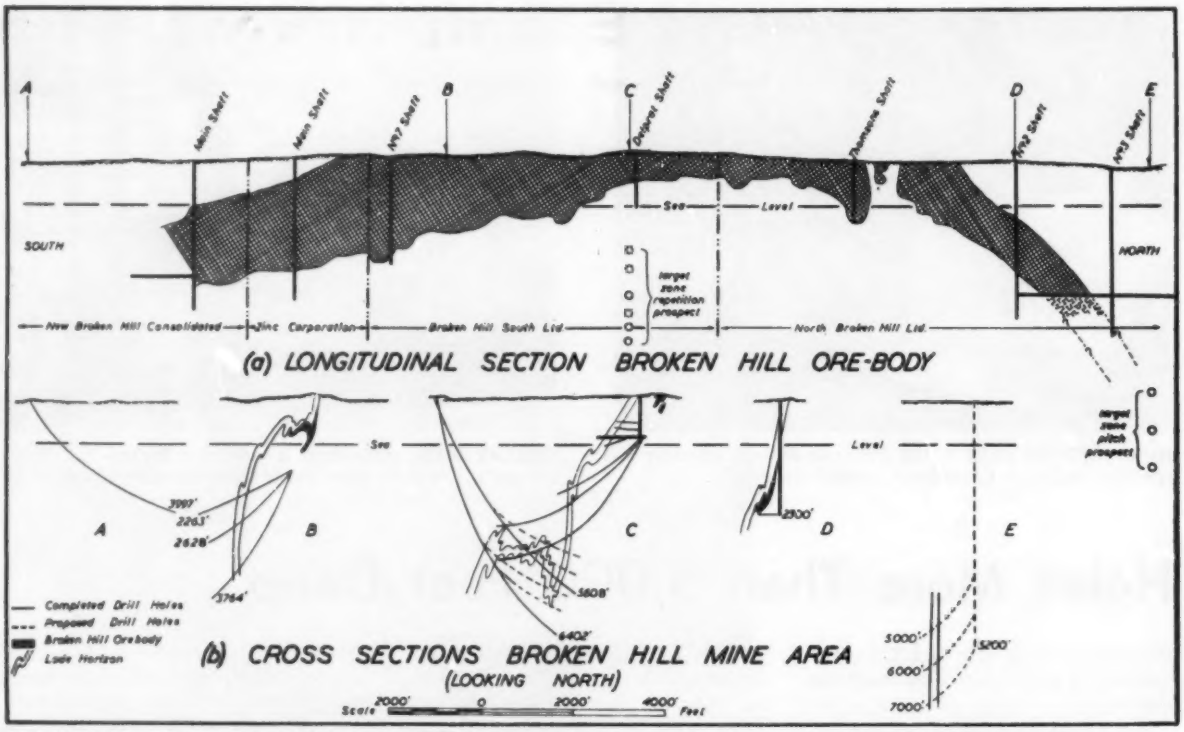
Despite these measures, bit troubles continued. At 4,353 feet a bit and reamer were left in the hole when the bit "burnt in". As this bit was pulled free, the reaction compression in the drill string belled the AW rods at their couplings. It was found that friction loss due to rust formation in the AW and B "streamflow" couplings should be reduced. Cleaning couplings cut friction loss by 56 pounds per square inch for AW rods while the change from a 20- to 10-foot-long core barrel saved an additional 50 pounds per square inch.

Filtered drinking water from the surface was used for drilling to insure clean water, but rusting took place. To overcome this rust resistance to water flow with the corresponding increase in pump duty the following recommendations were made by Mr. Copley: Couplings should be internally chrome-plated to prevent rusting. A water soluble rust inhibitor could be added to a closed drilling water circulatory system. Drilling operations could be continuous, 24 hours a day seven days a week, to minimize exposure of the rods to air while not in the hole.

Deep Drilling Targets

The Broken Hill lode is a type of fold ore body which presents much greater problems of location than a sheet-like or tabular ore body of an equivalent tonnage, reported B. R. Lewis, chief geologist, Broken Hill South Ltd. See diagram on next page to show the two main forms of the ore body—a dragfold or a series of drags respectively, lying on the generally steep dipping lode horizon. In both instances the bulk of the ore lies in a zone some 600 feet high. Thus a circle some 600 feet in diameter which can be regarded as continuous for say, five miles can be considered a target.

Geologically, there are two important reasons to drill cross-cutting or inclined holes rather than vertical. In the first place the lode horizon may be difficult to recognize without the rock succession for some distance on either side, and secondly, the folded nature of the horizon may offset its trend in depth to such a degree that the maximum amount of prior structural knowledge is desirable. Recent drilling targets have sought a repetition of ore down the dip and to the west of the main ore body. See longitudinal section and



GREAT LODE at Broken Hill, 22,000 feet in length, has produced some 80,000,000 tons of ore. North and south extensions are now being sought by very deep drilling as shownabove.

cross sections B and C. Underground drilling for this target has been briefly explained above. This drilling located a fold structure, partially beneath the city, which was further prospected by the two deep inclined holes also reported above. Deflection drilling from these two primary holes was in progress during the symposium.

At the north end of the lode, North Broken Hill Ltd. has a good start on a very deep drilling program seeking the down pitch extension of the ore body. A vertical hole was selected, from which deflections will be drilled at intervals less than the expected heighth of the ore body. A new drill designed to drill either vertical or inclined BX holes to a depth of 10,000 feet developed in Western Australia is being used.

Why Deep Holes are Vertical or Inclined

The causes for hole deviation and some of the methods used in Southern Africa for control were outlined by W. M. Adamson, manager, Unidrilling Ltd., Alberton, Republic of South Africa. All diamond drill holes deviate from their initial alignment. The amount and direction being dependent on several factors including drilling pressures which cause the rods and core barrel to buckle and exert a force slightly inclined to axis of the hole, layered rocks, structurally disturbed rocks, and possibly the earth's magnetic field and forces dues to the earth's rotation. Mr. Adamson reported that there is good reason to believe that gravity retards the rate of deviation. A drill hole might deviate rapidly to 50° from the vertical, but thereafter it tends to settle down at a more or less consistent angle of deviation.

Control of deviation is largely dependent on the type of rock. There are no problems drilling some types, many with other types. Drilling pressures must be controlled to avoid excess deviation. The penertation rate must be reduced to a minimum. High speed rotation with a slow penetration rate is essential. However, low-pressure high-speed drilling retards progress and increases diamond costs.

The larger the hole the better the chances of keeping it straight. Therefore, the hole should be drilled as large as economically practical, the barrel made as long as practical, and the hole clearance reduced to absolute minimum to prevent side thrust.

Correction of hole deviation is normally done with Hall-Row wedging method. It is particularly adapted to insure deflection in a given direction. However, deviation must be kept at a very low angle, preferably less than 4°. The take-off angle of the wedges varies from 1.5 to 2.25° with the result that full directional control can only be achieved with a single wedge when the angle of deviation of the hole is smaller than the wedge take-off angle.

The Weldon-Whitehead deflection method uses a hollow steel pilot rod the same diameter as core and is suspended by a shoulder above the core spring in such a manner that it is free to seek the vertical position. Attached to the pilot is a water turbine, to the runner of which a noncoring diamond bit is fixed. A water director with seal is inserted above the pilot to insure that the water enters the pilot. The tool string, with pilot, is lowered close to bottom of inclined hole so the pilot naturally rests on the lower side of hole. The string is held stationary while water admitted to rods drives the turbine and bit to drill a pilot hole as the string is slowly lowered. An anchor shelf is cut so drilling with the main string is started to establish a new hole eccentric to the original. END

PRODUCTION EQUIPMENT preview

FOR DATA ON ANY ITEM IN THIS SECTION PLEASE WRITE MANUFACTURER DIRECT

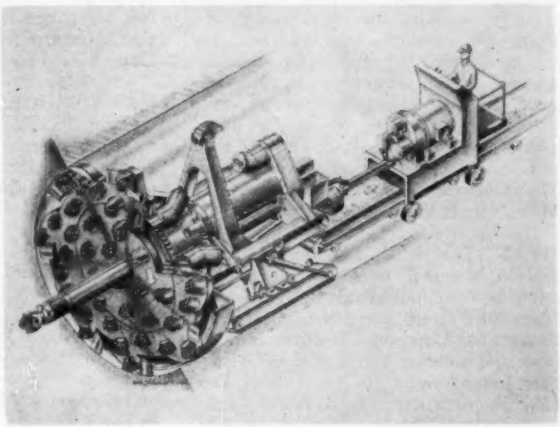
Unique Boring Machine Pulls Itself Into the Rock By Pre-Drilled Pilot Anchor

A unique, new boring technique, called the Alkirk Pilot-Pull Principle, developed and patented by the Alkirk Corporation, may have a significant influence on the future design of machines for drilling, tunneling, and excavating.

Machines operating on the pilot-pull principle literally pull themselves forward into the material to be bored by means of force exerted against a pilot which is anchored in the material ahead of the machine. The machine pulls itself in by its own bootstraps. In general, all previous boring machines achieved their thrust by pushing or bracing from behind, or the machine had to be heavy enough to provide its own thrust reaction. For this reason, there has been only a limited development of large diameter boring machines.

According to the Alkirk Corporation, machines incorporating the patented pilot-pull principle can be designed to accomplish almost any hole-making function. The advantages of boring machines which pull themselves into the material by means of hydraulically controlled feed pressures can be summarized as follows: (1) a faster method of boring large diameter holes in hard substances; (2) machine is lightweight, compact, maneuverable; (3) no external bracing or support is required—machine anchors to material; (4) boring possible at an angle, including vertical; (5) boreholes are true and smooth-surfaced as vibration of machine is eliminated; (6) machine is self-propelled, pulling itself forward on its anchored pilot; (7) virtually continuous boring is possible by means of self-advancing pilot; (8) feed of cutting tools controlled precisely with unlimited pressures.

A key factor in the development of the machine has been the solution of the problem of anchoring the pilot. There are



a number of ways of accomplishing this, depending upon the material being bored. One typical method is to hydraulically expand a rubber collar at the end of the pilot. The self-energizing rubber collar has proven capable of developing any pressures required for anchoring into the material being bored. Design studies have been made for an anchor with a holding capacity in excess of 1,000,000 pounds. For more information write: **Alkirk Corporation, Dept. MW, 7911 Tenth Avenue South, Seattle 8, Washington.**

Unusual Equipment Vehicle

The Wheel-Go is designed to transport a bulky 300 pound payload over difficult terrain with minimum effort. The powerful 2½ horsepower motor is compounded 36 times to provide unlimited power to both traction wheels.

The motor is governed by a hand throttle to co-ordinate the vehicle speed with a comfortable walking speed. A push-pull clutch knob is located near the finger tips of the left hand for easy control. The cargo rack may be held level even on extremely rough terrain as the "tractor" portion of the Wheel-Go pivots independently over logs, rocks, etc. Write: **N. L. Coffelt, Picus Manufacturing Company, Dept. MW, 12909 S. E. Powell Blvd., Portland 36, Oregon.**

For Filling Crusher Cavities

Plastic Pack, an epoxy resin compound for use in filling cavities between manganese wearing surfaces and structural steel members of crushers, is now available from Allis-Chalmers.

The resilient, non-shrinking compound does away with the need for elaborate application preparations associated with zincing. Easy to pour, it can be applied at the crusher site. It has a maximum copressive strength of 16,000 pounds per square inch. Plastic Pack is poured as a filler into the space between the head and mantle, or top shell and concave ring. An 11-pound Plastic Pack kit, selling for about $10.00, will fill the same area as 52 pounds of zinc. For more information write: **Allis Chalmers Manufacturing Company, Dept. MW, Milwaukee 1, Wisconsin.**

Free Industrial Gas Data Book

This 48-page booklet lists physical and chemical properties of industrial gases, and contains handy conversion tables providing a simple and fast method of changing volumetric information on the various industrial gases from one unit of measurement to another. For your free copy write: Air Reduction Pacific Co., Dept. MW, 100 California Street, San Francisco, California.

Submersible Dewatering Pump

A new submersible dewatering pump has been announced by the Gorman-Rupp Company. Model 3VS1 is a three-inch centrifugal powered by a five horsepower, 3450 rpm, 60 cycle electric motor, and is available in three voltage selections: single phase, 230 volt; three phase, 220 volt; or three phase, 440 volt.

Remote control box with overload protection and 75 feet of heavy duty electrical cable are standard equipment with each pump. Complete unit weighs just 128 pounds; pump only 95 pounds. The capacity range is 10 gpm at 120 feet of head to 300 gpm at 10 feet of head. Write: **Gorman-Rupp Company, Dept. MW, 305 Bowman Street, Mansfield, Ohio.**

FEEDERS that vary in width from 24 inches to 60 inches, and can take the heaviest shock loads are described in bulletin "Gruendler Heavy Duty Grizzly and Straight Pan Feeder Units." For a copy write: **Gruendler Crusher & Pulverizer Company, Dept. MW-1061, 2915 N. Market Street, St. Louis 6, Missouri.**

DRY PROCESSING equipment bulletin, now available from Sturtevant Mill Company, includes information on crushers, grinders, pulverizers, micron-grinders, air classifiers, granulators, blenders, mixers, feeders, screens, elevators, conveyors and mechanical dens and excavators. For a free copy of this eight-page bulletin write: **Sturtevant Mill Company, Dept. MW, Boston 2, Massachusetts.**

"HOW TO USE Manganese Rods and Weldments" is the title of a 16-page booklet published by American Manganese Steel Division of American Brake Shoe Company. It offers instructions and welding tips useful in the repair and rebuilding of worn parts. For your free copy write: **G. R. Bason, Manganese Steel Division, Dept. MW, 389 East 14th Street, Chicago Heights, Illinois.**

FLEXIBLE RUBBER sound and vibration eliminators are described in a new illustrated SoundZorber Catalog No. 890, covering General Rubber Corporation's complete line. The SoundZorber line has been specially designed and constructed to eliminate noise and vibration disturbance in pipe lines on air conditioning, heating, and refrigeration systems. For a free copy write: **General Rubber Corporation, Dept. MW, 70 Summit Street, Tenafly, New Jersey.**

INFORMATION frequently requested by engineers such as bearing life expectancy, shaft deflection, interchangeability charts and diagrams as well as the usual complete performance, application and dimension data is included in the revised edition of Bulletin No. 725.1 describing the new line of chemical process pumps recently introduced by Goulds Pumps, Inc. For your copy write: **Goulds Pumps, Inc., Dept. MW, 225 Black Brook Road, Seneca Falls, New York.**

TRACTOR-SCRAPER: Complete details of the new 619C tractor-scraper manufactured by Caterpillar Tractor Company are contained in a new booklet issued by the company. Point-by-point features of the 619C are described including the choice of power shift or direct drive, the four-cylinder 280 maximum horsepower engine, the improved Lowbowl scraper, and the features of fast servicing. Write: **Advertising Division, Caterpillar Tractor Company, Dept. MW, Peoria, Illinois.**

DATA PROCESSING systems including the Beckman Model 210 Data Acquisition unit are described in a new, eight-page bulletin that includes photos, specifications, applications, and detailed descriptions of the Model 210 and its subsystems. Write: **R. A. Elms, Systems Division of Beckman Instruments, Dept. MW, 2400 Harbor Boulevard, Fullerton, California.**

DRILLING RIG bulletins describing the powerful new line of Le Roi blast hole rigs from two-and-a-half to seven-and-three-eights inch hole size that can be truck, crawler, or wheel mounted will be mailed on request. Write: **J. R. Buck, Le Roi Division, Westinghouse Air Brake Company, Dept. MW, Sidney, Ohio.**

DRILLING RIGS: Ingersoll-Rand announces the availability of the new 20-page booklet covering special rock drilling rigs for construction, mining, tunneling, and submarine work. The booklet shows many on-the-job photos of special rigs engineered to meet exact requirements of each job. Write: **Ingersoll-Rand Company, Dept. MW, 11 Broadway, New York 4, New York.**

TIMBER TREATMENT: "Wolmanized Pressure-Treated Mine Ties, Timbers and Lumber" is an illustrated eight-page brochure on wood protected against deterioration from rot-producing fungi. Used for above-ground and below-ground applications, Wolmanized timber provides safer, less hazardous mine operation, improved production, reduced maintenance and operating costs. Write: **D. E. Birkhimer, Wolman Preservative, Koppers Company, Inc., Dept. MW, 750M Koppers Building, Pittsburgh 19, Pennsylvania.**

VARIABLE-SPEED belts is the subject of a new 20-page bulletin that contains valuable information for those seeking replacement of belting. Write: **T. B. Wood's Sons Company, Dept. MW, Chambersburg, Pennsylvania.**

TESTING SIEVE Bulletin F-S-61 that gives complete technical data on all types of testing sieves including new 1961 ASIM, NBS and ASA sieve standards has been published. Write: **J. L. Campbell, Newark Wire Cloth Company, Dept. MW, 351 Verona Ave., Newark 4, New Jersey.**

CORE DRILL MACHINE: 142-C is the answer to deep-hole and large diameter diamond core drilling. The new eight-page Bulletin No. 170 describes in detail all the features of this efficient drill. Write: **Sprague & Henwood, Inc., Dept. MW, Scranton 2, Pennsylvania.**

"JUST MIX AND POUR": is the title of a new six-page bulletin which describes the new non-metallic backing agent, Nordbak. Originally developed for use in Symons Cone Crushers, Nordbak is now widely used for that purpose as well as in gyratory crushers, grinding mills, and other machinery where backing agents are required. For a copy of the panoramic story of Nordbak write: **G. R. Wenzel, Nordberg Manufacturing Company, Dept. MW, Milwaukee, Wisconsin.**

SLURRY THROTTLING problems are solved with the Clarkson "C" valve according to the Clarkson Company. This is said to be the only valve designed specifically to stand up under the continual abuse of throttling control of highly abrasive materials. For information write: **The Clarkson Company, Dept. MW, 735 Lona Verde Avenue, Palo Alto, California.**

INDUSTRIAL PUMPS are described in catalogs issued by John Bean. High pressure reciprocating pumps with capacities from 0.5 to 100 gallons per minute, and pressures from 100 to 12,000 pounds per square inch are detailed. Write: **John Bean, Food Machinery and Chemical Corporation, Dept. MW-8, San Jose, California.**

New Safety Feature for Tunnel Roof Anchor Bolts Eliminates Sudden Mine Cave-Ins

The availability of a new type of safety indicator for use with tunnel roof anchor bolts to give indication of imminent mine cave-ins is now available.

In the construction of mine tunnels, it is the present practice to secure the rock strata of the tunnel roof with anchor bolts about six feet long in regularly spaced holes drilled upward into the rock. As contrasted to timber beams and props, anchor bolts do not obstruct the passage, require only minimal material, and can be installed easily with standard tools.

On the other hand, when rock strata do shift, the tie bolts do not sag noticeably and give warning as the timbers do. Thus, there is practically no advance indication of dangerous stress conditions before the bolts actually break. When mine crews know that dangerous stresses are developing, they can often put in additional ties and shoring and thus prevent a cave-in.

The purpose of the simple device now available is to increase mine safety by giving a direct and immediate indication of dangerous loading on a mine tunnel roof anchor bolt. This is done by the use of a washer, a shoe, and a two-foot long indicator flag of aluminum. When the flag droops as a result of undue stress in the bolt, it is visually noticeable to anyone in the area so that remedial action can be taken to shore up the tunnel roof or get out before the roof caves in. Write: **Ladd & Little, Inc., Dept. MW, 570 Walt Whitman Road, Huntington Station, L. I., New York.**

Explosives Bulletin Available

A four-color, 16-page bulletin No. 101 is available from Trojan Powder Company describing the Trojan line of high explosives, Trojan Seismic explosives for land and off-shore exploration; Trojan nitrocarbonitrates; Trojamities; primers and boosters, etc.

Tables gives cartridge counts on practically every type and size of cartridge in the Trojan line. Local distributing points are listed. Write: **N. P. Hewitt, Trojan Powder Company, Dept. MW, 501 Cooper Street, Camden, New Jersey.**

Portable Beryllium Detector

A portable beryllium detector has been developed by the Boulder Scientific Company which will detect beryllium in rocks containing as little as 0.01 percent BeO. It will penetrate to a depth of about three inches. The unit weighs only 20 pounds when in use, and ultilizes highly stable transistorized electronic circuits. The instrument uses a 50 millicurie source of antimony 124 which has a useful life of four to six months. Write: **J. R. De Haan, Boulder Scientific Company, Dept. MW, 250 Pearl Street, Boulder, Colorado.**

How to Select Locomotives

Recognizing the importance of selecting the right size and type of power haulage unit to meet a specific service range, Plymouth Locomotive Works, has just issued a technical report titled "How to Select Industrial Locomotives." The report is recommended reading for every user of industrial locomotives, and acquaints the reader with such basic locomotive-selection factors as rail size, road beds, rail capacity and gauge. Such highly specific problems as grades, grade resistance, curves and curve resistance are explained in easy-to-understand language. Typical examples, as well as simple, quick-reference tables are used to clarify the more technical points. For a free copy of this important record write: **Plymouth Locomotive Works, Dept. MW, Plymouth, Ohio.**

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only one moving part makes dependable percussion drilling power

The piston is the only moving part, which means less wear and less trouble. No complicated valving to sand up as in many bottom hole pneumatic impact tools. You can easily change the choke which adjusts the Hammerdril to the air volume needed from your 100 psi compressor. The Series 100 Hammerdril® is an air miser, too. All the air goes through the Hammerbit® to clean or to drill. None is wasted. This splined, one piece Hammerbit has heavy tungsten-carbide inserts for long life. Service is available in your area. Write for new bulletin.

MISSION MANUFACTURING CO. HAMMERDRIL

P. O. BOX 4209 • HOUSTON, TEXAS / OVER THIRTY YEARS OF DRILLING RESEARCH

Metal & Mineral Prices

U. S. A.

November 17, 1961

METALS

COPPER: Electrolytic. Delivered F.o.b. cars, Valley basis (pound)	31.00¢
Lake. Delivered, destinations, USA	31.00¢
Foreign. Delivered, destinations, USA	31.00¢
LEAD: Common Grade. New York (Per pound)	10.00¢
Tri-State Concentrate, 80% lead, per ton	$110.76
ZINC: Prime Western: F.o.b. E. St. Louis (Per pound)	11.50¢
Prime Western: Delivered New York	12.00¢
Tri-State Concentrate, 60% zinc per ton	$68.00
ALUMINUM: Primary 50 Pound Ingots (99.5% plus) (Per pound)	24.00¢
ANTIMONY: Lone Star Brand. F.o.b. Laredo, in bulk (Per pound)	33.00¢
BISMUTH: (In ton lots) price per pound	$2.25
CADMIUM: Sticks and bars. 1 to 5 ton lots Price per pound	$1.60
COBALT: 97-99%, keg of 500 pounds (Price per pound)	$1.50
COLUMBIUM: Ingot Nominal, per pound	$36.00-$55.00
GERMANIUM: dioxide, high purity, gram	16.75-21.75¢
LITHIUM: 98% (per pound)	$9.00-$12.00
MAGNESIUM: Ingots (99.8%) F.o.b. Velasco, Texas per pound	36.00¢
MERCURY: Flasks. Small lots, New York	$188.00-$191.00
NICKEL: "F" Ingots (5 pounds) F.o.b. Port Colbourne, Ontario	82.75¢
PLUTONIUM: To July 1, 1962 AEC will pay $30.00 to $40.00 per gram depending on plutonium 240 content. July 1, 1962 to June 30, 1963, per gram	$30.00
SELENIUM: 99.5% per pound	$5.75
TELLURIUM: Common grade, Per pound	$5.25
THORIUM: per kilogram	$43.00
TIN: Grade A Brands. New York (Per pound) Prompt delivery	123.625¢
TITANIUM: 99.3% + Grade A-1 Sponge (Per pound)	$1.37-$1.60
URANIUM: Normal, Per Pound	$24.00
VANADIUM: 90% Grade	$3.45
GOLD: United States Treasury Price	$35.00 per ounce
London	$35.16 per ounce
SILVER: Newly mined domestic. U.S. Treasury price per ounce	90.5¢
Foreign Handy Harmon	91⅜¢
PLATINUM: Per ounce	$82.00-$85.00
ZIRCONIUM: Sponge, Per pound, Reactor Grade	$5.00

ORES AND CONCENTRATES

BERYLLIUM ORE: 10 to 12% BeO. F.o.b. mine, Colorado	$46.00 per unit
Small lot purchases at Custer, S. D., Spruce Pine, N. C., and Franklin, N. H. Visual inspection at $400.00 per short ton or by assaying at 8.0 to 8.9% BeO, $40 per unit; 9.0 to 9.9%, $45; over 10.0%, $48.00.	
CHROME ORE: F.o.b. railroad cars eastern seaports. Dry long tons.	
African (Rhodesian). 48% Cr_2O_3. 3 to 1 ratio	$35.00-$36.00
African (Transvaal). 48% Cr_2O_3. No ratio	$26.00-$28.00
Turkish, 48% Cr^2O^3. 3 to 1 chrome-iron ratio Nominal	$36.00-$37.00
COLUMBIUM-TANTALUM ORE: Per Pound Pentoxide, Nominal	$1.10
TANTALUM: 60%	$7.00
IRON ORE: Lake Superior. Per gross ton Lower Lake Ports	
Mesabi, Non Bessemer, 51.5% Fe	$11.45
Coarse: Plus–½-inch	$12.85
Fines: Minus–½-inch	$10.72
Mesabi, Bessemer, 51.5% Fe	$11.60
Old Range Non Bessemer	$11.70
Old Range Bessemer	$11.85
Swedish, Atlantic Ports, 60 to 68% Fe Contracts, Per Unit	24.00-25.00¢
Brazilian, Atlantic Port, 68 to 90%, Long ton unit	22.00-22.50¢
Venezuelan, Orinoco No. 1, 58% Fe, f.o.b. Puerto Ordaz	$8.95
MANGANESE ORE: Metallurgical grade. 48 to 50% Mn Long ton unit	$0.90-$0.95
Metallurgical grade. 46 to 48% Mn. Long ton unit	$0.85-$0.90
Metallurgical grade. 44 to 45% Mn. Long ton unit	$0.85-$0.90
Domestic U.S. Government. GSA Basis $2.30 per unit for 48% Mn.	
MOLYBDENITE CONCENTRATE: 90% MoS_2 F.o.b. Climax, Colorado. Per pound Mo, plus container cost	$1.40
TUNGSTEN CONCENTRATE: Domestic. 60% WO_3 Per short ton unit Nominal	$22.50
Foreign: 65% WO_3 Per short ton unit (Scheelite) Nominal	$16.00
Foreign: South American, Spanish, Portuguese Nominal	$14.00
URANIUM ORE. F.o.b. purchase dep ᵗ or company mill in accordance with AEC schedules and company buying contracts. Basic price is $1.50 per pound of U_3O_8 in ore assaying 0.10 percent. For each additional 0.01 add 20¢. Subject to development allowance, premiums, penalties where applicable.	

NON-METALLIC MINERALS

BARITE: Oil well drilling. Minimum 4.25 specific gravity, per short ton	$16.00
BENTONITE: Minus-200mesh. F.o.b. Wyoming. Per ton, carload lots	$12.50
Oil Well grade. Packed in 100 pound paper bags	$14.00
BORAX: Tech., gran., decahydrate, 99.5%, bags; cl., works, short ton	$50.00
FLUORSPAR: Metallurgical grade. 72.5% effective CaF_2 content per short ton F.o.b. Illinois-Kentucky mines	$37.00-$41.00
Mexican. 70% F.o.b. border, Duty paid	$27.00-$28.00
Acid Grade. 97% CaF_2 Bulk, F.o.b. mine	$45.00-$49.00
PERLITE: Crude: F.o.b. mine per short ton	$3.00 to $5.00
Plaster grades. Crushed and sized. F.o.b. plants	$7.00 to $9.00
SULPHUR: Long ton, f.o.b. cars. mines	$22.50-$23.50
F.o.b. vessels Gulf Ports	$24.00-$25.00

London

November 17, 1961

		Per Long Ton	USA Equivalent	cents per pound
COPPER:	Electrolytic, spot	£227	5s 0d	28.41¢
LEAD:	Refined 99%	£ 59	15s 0d	7.47¢
ZINC:	Virgin 98%	£ 68	10s 0d	8.56¢
ALUMINUM:	Ingot, 99.5%	£186	0s 0d	23.25¢
ANTIMONY:	Regulus, 99.6%	£230	0s 0d	28.75¢
TIN:	Standard, 99.75%	£971	0s 0d	121.38¢
TUNGSTEN:	Long ton unit	to	110s 0d	$15.40

***With Sterling Pound at $ 2.80**

Quotations on metals and certain ores through the courtesy of *American Metal Market, New York, New York*

WHAT'S GOING ON in mining

By **Dr. E. F. Cook**, director of the Idaho Bureau of Mines and Geology, Moscow, Idaho. His participation in this international symposium was made possible by a travel grant from the National Science Foundation.

VOLCANIC SPECIMEN examination by Dr. Cook (the author) at right; Dr. Fuster from Spain, left; and E. F. Osborn, Pennsylvania State University. The place is Catonia, Sicily.

Ignimbrite Symposium Gives Clues To Buried Ore Bodies

More than 100 geologists from 18 countries met in Pisa, Italy, on September 15 to begin a 16-day traveling "Symposium on ignimbrites and hyaloclastites." Probably not many more than 100 people in the world can even pronounce those two words, let alone tell you what they mean. And after 16 days of discussion and field excursions, there were still disagreements among us geologists who participated as to what the words really mean!

Ignimbrites (according to me) are sheet-like pyroclastic deposits, which may be soft or may be so hard that they resemble lava flows. Most of the so-called rhyolite and dacite flows in the Great Basin of the United States are ignimbrites. Ignimbrite means "fiery cloud rock"; some geologists don't like the term and prefer to use ash flow or even welded tuff, although most of the deposits are only partially welded and some not at all.* They form by deposition of hot bits of lava, crystals, pumice, and rock fragments from rapidly spreading, subaerial density currents that have been variously called glowing clouds, tuff flows, glowing avalanches, and ash flows. Such gas-solid flows are produced when gaseous magmas are abruptly released from high confining pressure. Hyaloclastites, as far as I know, are not important in the United States, so I'll not attempt to define the term.

Ignimbrites have been, in the past few years, recognized in many parts of the world; the number of geologists working with such rocks and interested in their puzzling features is growing. Consequently, there was great interest in the Italian meeting, sponsored by the International Association of Volcanology and organized by Dr. Alfred Rittmann of Catania (Sicily), president of the Association and author of the classic book, *Volcanoes and Their Activity*. The countries of western Europe, from Finland and Norway to Spain, accounted for the bulk of the registrants, but Australia, New Zealand, Japan, Israel, and Iran were also represented, while Hungary and the Soviet Union sent four delegates each and seven of us came from the United States. The United States was represented by E. F. Osborn, vice-president in charge of scientific affairs of the Pennsylvania State University (formerly Dean of Penn State's College of Mineral Industries); Robert L. Smith and Donald White of the United States Geological Survey; Felix Chayes, United States Geophysical Laboratory; Charles J. Vitaliano, Indiana University; Adrian Richards, United States Navy Electronics Laboratory; and the author.

A Clue To Ore Deposits?

Of all the participants, only three from the United States were interested in the relation of ignimbrites to ore deposits. In the western United States, many ore deposits are closely related to small intrusive bodies which are in turn genetically related to extensive ignimbrite sheets. Charles Vitaliano pointed out in the paper he presented at the Sicily meeting that all of the ore deposits of the Goldfield-Tonopah-Austin area are older than the widespread younger ignimbrites of the area and are associated with some of the older units of the Tertiary volcanic sequences. It can be seen that ability to recognize separate ignimbrite formations could be useful in exploration; furthermore, because compaction structures in ignimbrites can be measured just as bedding of sedimentary rocks is measured, detailed mapping of these volcanic sheets in areas where they have been deformed may well result in finding buried intrusive bodies with satellite or related ore deposits.

After all, there is no reason to believe that ore deposits hidden beneath the volcanic rocks and alluvium that cover about two-thirds of the Great Basin are any less abundant or less rich than those which already have been found. Vitaliano, working out the volcanic sequence in western Nevada, and I, tracing ignimbrites over some 20,000 square miles in eastern Nevada (some ignimbrites, products of single gigantic eruptions, cover as much as 10,000 square miles), have both been intrigued by the exploration possibilities inherent in ignimbrite study. Don White, an expert on thermal waters and associated ore deposition, also is interested in the general problem of relation of ore deposits to such volcanic rocks.

Four days were spent in the field between Pisa and Rome. Then the group moved to Catania for three days of formal sessions and two days of excursions. After the Catania stay, we spent four days traveling through the volcanic Eolian Islands, using for transport an Italian Navy minesweeper that had been placed at our disposal. The marathon meeting ended with three days of field excursions out of Naples. Highlights of the meeting were ascents of two active volcanoes (Etna and Stromboli) and two temporarily dormat volcanoes (Vesuvius and Volcano). Etna is smoking furiously from a double crater, sending up a white plume from one vent, a brown cloud from the other; since spring a small lava flow has been pouring from a small wound in her flank. Stromboli at frequent intervals sends up lava fountains to the accompaniment of a throaty, whooshing roar.

Geologists Cooperate

The Russians and the Hungarians arrived late, missing the first six or seven days of the meeting. At first we thought the Iron Curtain had slammed down on travel to scientific meetings, but when the Hungarians came they blamed the delay on the slowness of Italy in issuing visas for them. Asked why they were late, the Russians came back with a typical Russian answer: "We started late."

Mingling of nationalities reflected the overriding interest of the participants in the subject matter. One night seven of us (three Russians, two Americans, and two Italians) lost the trail coming down after nightfall from a visit to the crater of Stromboli; it was a fortunate example of international cooperation that ended in our refinding the path with no more harm than scratches and bruises from falls on the steep, brushy slopes of the volcano.

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* Recent papers that summarize present knowledge of ignimbrites and review the history of their study are:

Cook, E. F., 1961, Great Basin ignimbrites: Intermountain Assn. Petr. Geol. **Guidebook to the Geology of East-Central Nevada**, p. 134–141.

——, 1961, Ignimbrite Bibliography: Idaho Bur. Mines Geol. Inf. Circ. 4 (2nd edition).

Ross, C. S., and Smith, R. L., 1961, Ash flows: their origin, geologic relations, and identification: **U. S. Geol. Survey Prof. Paper 366**, 81 p.

Smith, R. L., 1960, Ash flows: **Geol. Soc. America Bull. v. 71**, p. 795–842.

Arizona

Regular and extensive pattern diamond drilling has been underway by Kennecott Copper Corporation's exploration subsidiary—**Bear Creek Mining Company**—at and surrounding the **Old Reliable** copper mine on Copper Creek, Pinal County, Arizona. Copper has been produced for many years at the Old Reliable from a stock like intrusive. So extensive and detailed has been Bear Creek's drilling that independent geologists believe that all possibilities for ore discovery have been checked.

A gas-fired rotary-type dryer has been installed at the concentrator by **Inspiration Consolidated Copper Company,** Inspiration, Arizona. The new equipment, by removing excess moisture, is expected to make possible a reduction in smelter costs. Inspiration's concentrator in 1960 treated 4,964,778 tons of leached ore and produced 59,906 tons of flotation concentrate with a copper content of 23.161 percent. Experimental work had shown the possibility of increasing the copper content of the concentrate by revising metallurgical procedure, and plant-scale tests are underway. Inspiration reports that results to date have been most gratifying and indicate that substantial economies in smelting will be realized as a result of reducing the tonnage of concentrate.

A process for copper ore treatment has recently been patented by Frank E. Horton of Tucson, Arizona, mill superintendent for **Banner Mining Company** of Tucson. The copper extraction method prepares an electrolyte from oxidized copper ore particles that contain substantial amounts of chrysocolla which are unsuitable for acid leaching because of the presence of calcium and/or manganese carbonates. The process consists of leaching the ore particles with a water solution of sodium hydroxide and potassium hydroxide of a concentration of between 5 and 10 normal, to produce a solution containing cuprate anions. Ore particles are scrubbed during the leaching to remove silica gels, so that the surfaces of the ore particles are continually exposed to continued leaching.

Stockpiling of fluorspar by **General Services Administration** has started at the recently acquired site in Douglas, Arizona. In preparing for the actual storage, a trench 20 feet deep, 270 feet long and 80 feet wide was excavated. The floor and walls are asphalt lined, and will be covered with an arching five-foot roof constructed of wire mesh and canvas stucco coated with asphalt. The fluorspar to be stockpiled is mined from deposits near Esqueda, Sonora, Mexico, and shipped by rail to Douglas, Arizona. When delivered, the material is in a semi-finished form, having been ground at the mine, with a high percentage of the impurities removed by flotation. The fluorspar is being acquired by the United States under barter arrangements with Mexico whereby surplus wheat is exchanged for the mineral. Present plans call for the acquisition of 25,000 to 30,000 tons by December 1961. The stockpiling program is being supervised by Robert E. Reno of San Francisco, regional director, Defense Materials Service, General Services Administration.

California

New Equipment Purchased for Kaiser's Eagle Mountain Pit

A major expansion in iron ore production is slated for Kaiser Steel Corporation's Eagle Mountain iron ore pit to meet demands of the Fontana steel plant and export ore schedules. The high operating rate of the blast furnaces to supply hot metal to the oxygen fired converters, and pig iron for export to Japan coupled with off-shore shipping commitments necessitates the purchase of additional mine equipment.

A new Bucyrus-Erie 280 12 cubic yard electric shovel, six new 100-ton KW-Dart Diesel trucks, three new Ingersoll-Rand Quarry Master drills, Caterpillar bulldozers, and water trucks have been ordered.

The existing heavy media section of the beneficiation plant will be enlarged and a magnetic concentration unit built to handle fine ore feed.

Utah Construction Maps Southern Vancouver Island

Geological field crews of the Utah Construction and Mining Company have spent a busy summer and fall mapping the south and southeast end of Vancouver Island. Particular emphasis was placed on regional fault lines, intrusives, limestone beds, and contacts.

Both copper and iron were the minerals sought with special attention to contact metamorphic zones along contacts. Airborne geophysical surveying may be a future part of the program.

Utah has also been exploring the Prince of Wales island in Alaska through its subsidiary—Mount Andrew Mining Company.

Company geological headquarters are in San Francisco, California, under the direction of W. Bourret, vice president of geology and exploration.

Shipments of iron ore to Japan paced the establishment of a new record at the port of Stockton, California, when a history-making 91,389 tons of outgoing cargo were handled by the bulk ore terminal in one week last July. To Japan went 82,365 tons of iron ore in four ships, 2,748 tons of coke in one ship, and 5,246 tons of potash in one ship. Adding to the record, but destined to Hawaii, was 1,020 tons of aggregate.

Central

National Mining and Engineering Company plans to locate offices in Poplar Bluff, Missouri, and expects to mine and ship iron ore from deposits in the vicinity of Shook, Burbank, Hiram, Lowndes, and Greenville, Missouri. If plans materialize, ore will be shipped by rail and truck to Cape Girardeau on the Mississippi River, and there loaded on barges destined for Pittsburgh, Pennsylvania.

More than 120 engineers attended the recent meeting of the Association of Missouri Geologists at Ironton, and spent two days studying the pre-Cambrian area rocks as well as making visits to the Taum Sauk electric project, Midwest Ore, and Viburnum mines.

COMPANIES IN THE MINING WORLD NEWS

Early in October 1961, the new development shaft at **White Pine Copper Company's** new Southwest ore body reached a depth of 1,719 feet. The 20 feet diameter, concrete-lined shaft, was expected to reach its final depth of 2,300 feet in the middle of November. When it has been bottomed, the contractor will cut stations and add the loading pockets. Also, when the shaft is completed, White Pine will test the amenability of the ore to concentration in its 16,000 ton per day flotation concentrator. White Pine anticipates no difficulty in the metallurgy of this deep ore based upon laboratory studies of diamond drilling results. If the pilot studies prove successful, White Pine plans to begin full production from this ore body in 1964.

A campaign to prevent injuries from falls of ground in mines has been announced by the Mining Section of the National Safety Council. The campaign will begin January 1, 1962 and end December 31, 1962. The campaign goal is a 50 percent (or better) reduction in the frequency rate of injuries from falls of ground, and presents a challenge to large and small mines alike to reduce this needless waste of life and human values, not to mention the tremendous economic loss to the industry. All underground mines, excluding coal, are urged to participate in the campaign.

St. Joseph Lead Company has shut down all undergraduate operations of the **National** mine at Flat River, Missouri, and "clean-up" operations at the **Bonne Terre** mine, shut down earlier in 1961, are now completed.

Colorado

The newest concentrator of the **Vanadium Corporation of America** went on stream in October at Naturita, Colorado, and is processing some 400 tons-per-day of uranium-vanadium ores. The facility will handle ore from both contract and independent mines with the concentrate being trucked to Vanadium Corporation's Durango mill for further processing. The concentrator is of an entirely new design, and the finished concentrate will be in pellet form. This is expected to save approximately 75 percent of the previous haulage costs of crude ore to Durango.

Rico Argentine Mining Company, with properties in Colorado's Rico district and sulphuric acid plant faciilties in the same area, reported net profit before depreciation and depletion for the fiscal year ended June 30, 1961, of $90,545. This compares with a net profit on a like basis for the previous fiscal year of $42,981. During the present fiscal year the company hopes for a 65 percent increase in H_2SO_4 production, and expects to apply for a small mines subsidy under the new legislation recently approved by Congress.

U. S. Beryllium Corporation has entered into a joint development agreement with the owner of 13 molybdenum claims in the Virginia Peak and Cross Mountain area of Chaffee County. U. S. Beryllium already holds an interest in other claims in the area according to Don H. Peaker, president.

Eastern

Kennecott Seeks Second Cerro de Pasco in Central Andes

The Kennecott Copper Corporation has initiated a diamond drilling campaign at its Pacoyan prospect, 10 miles west of the Cerro de Pasco mine, and hopes to discover a sulphide deposit similar to the famous Cerro de Pasco ore bodies. Drilling is being done by Cia. "Diamantina B.H." S.A. Peruvian representatives of Boyles Brothers of Canada, Ltd.

Kennecott's permanent staff in Peru became interested in the Pacoyan property in early 1961, and began a detailed geologic investigation. Results of this preliminary work were encouraging, and led to an option agreement with the owners, and the present drilling program. Geologic similarities between this prospect and the nearby Cerro de Pasco deposit are striking, and has led some observers to believe that this may be another large sulphide pipe containing massive copper-lead-zinc-silver ores.

The exploration office of the Kennecott Copper Corporation in Peru is headed by Fred E. Towsley, formerly of Timmons, Ontario, Canada.

After being on a development basis since February, the **American Zinc Company of Tennessee** has closed down its **Coy** mine at Jefferson City, Tennessee. Of American Zinc's five mines in the east Tennessee zinc district, only two (the **Young** mine in Jefferson County and the **No. 2** mine in Mascot County), are still operating.

Tennessee Coal and Iron Company, subsidiary of **U. S. Steel Corporation,** is installaing a new automatic skip hoisting arrangement at its Jefferson City, Tennessee, zinc mine.

Tri-State Zinc Company has completed the engineering on its 2,100-foot circular shaft to be sunk at New Market, Tennessee. Rather than the usual ladderway for emergencies, plans call for installation of a small Diesel-powered hoist. It is expected to take three to four years to complete the shaft once sinking has started.

Tennessee Copper Company is doubling its facilities to produce liquid sulphur dioxide. The work now in progress will result in a second or "B" unit for compressing sulphur dioxide gas to liquid form at the plant located on the Copperhill-to-Ducktown highway.

A $12,000,000 program of geologic mapping to be undertaken by the State of Kentucky and the United States Geological Survey will cover the entire state within about 10 years. The program is the result of an earlier project in which some 763 topographic quadrangle maps of the state were completed. These maps form the basis for the present geologic project in which scientists will turn out multicolored geologic maps on a virtual scientific assembly-line. Although the program is dependent on both national and state funds—available, as planned, it is much larger in scope than an comparable statewide geologic mapping program. The maps, on a scale of 1:24,000 will be single sheets with geologic explanations and diagrams showing rock layers and describing major rock formations.

Koppers Company Dedicates $8,500,000 Research Center

Representing an investment of approximately $8,500,000, Koppers Company, Inc. dedicated its newest and largest research facility at Somervell Park, Monroeville, Pennsylvania, on August 28. The research center consists of a five-story administration building, three 3-story interconnecting laboratory wings, and several outlying auxiliary buildings. A feature of the center which contributes to easy expansibility are the glass enclosed stairways at the end of each wing which can be easily removed when additions are called for, and reaffixed to the end of the new wing. Only about one-third of the buildings planned for the 176-acre site have been completed, but no firm schedule for the remaining construction has been set. According to Dr. Paul W. Bachman, Koppers vice president and director of research, the center will eventually be able to house over 1,500 scientists and their assistants—about four times its present population.

Idaho

At the properties of **Silver Star-Queens Mines, Inc.**, near Hailey, Blaine County, Idaho, **Federal Resources Corporation** is crosscutting toward the Bonanza King vein under a joint venture agreement approved in August. The Salt Lake City, Utah firm plans to do at least 1,500 feet of underground drifting.

Clearwater Mines, Inc., has reopened its 2,000-foot tunnel on Niagara Creek in eastern Shoshone County, Idaho, and retimbered parts of it. Access was gained to sections of copper-silver-gold ore of milling grade, and tunnel work is planned for next season. H. G. Loop, Spokane, Washington, is president.

The **Bunker Hill Company**, largest operator in northern Idaho's Coeur d' Alene mining region, has taken over development of the **Nancy Lee** lead-silver-copper mine near Superior, Mineral County, under a lease agreement with **Nancy Lee Mines, Inc.**, Kellogg, Idaho. The initial program includes improvement of the adit, determination of the full length of the Nancy Lee ore shoot, and deepening the 790-foot shaft to test the ore body at that deeper level. The transaction included purchase of the lease, mining equipment, and 120-ton flotation mill of E. G. Smith, Osburn, Idaho, for $100,000.

An NX diamond drill hole has been put down 113 feet by **R. G. Mining Company** at its property in the Beaver Creek area north of Wallace. Some galena was cored and additional work is planned. Ray Klepinger, Kellogg, is president.

A second carload of silica rock has been shipped to Seattle by **Lyndon's Inc.** from quarries on Mason Butte, southwest of Craigmont, Lewis County. Charles Stickler, Lewiston, is company president.

The new North vein found in 1959 on the 3,000-foot level of the **Galena** mine west of Wallace, Shoshone County, has been opened for more than 150 feet on the lower 3200 level at last report. It is said to average more than 100 ounces of silver and two percent copper to the ton over a mineable width. **American Smelting and Refining Company** is the operating firm.

The last 150 feet of the No. 3 shaft at the **Galena** mine, Shoshone County, Idaho, was sunk through a pilot raise driven up from the 1,600-foot level with a "raise climber" machine. Shaft sinking crews required only 11 working days to do the drilling, blasting, cleaning down of muck and placing of steel sets. The mine is operated under lease by **American Smelting & Refining Company.**

Iron Ranges

Republic Mill Expansion of Cleveland-Cliffs On Schedule

Construction of the first section of the enlarged Republic mill by The M. W. Kellogg Company at Republic, Michigan, is on schedule and the 800,000 tons per year concentrator will commence production shortly. Erecting the first 800,000 ton per year pelletizing plant is expected to be completed during early February 1962, and further expansion of the mill and agglomerating plant is scheduled for completion in October.

At present the 300- by 220-foot addition to the north side of the Republic concentrator is over two-thirds complete. All mills, including two 10½- by 14-foot primary ball mills, two 9½- by 16-foot rod mills, and three 10½- by 19½-foot regrind mills, are in place. The ball and rod mills are driven by 700-horsepower motors, whereas the regrind mills are driven by 1,000-horsepower motors. The new concentrating section will be equipped with two flotation and two regrind units. The old section, which has been in operation since 1956, has two flotation units and does not regrind the concentrate.

With 132 flotation machines in place, M. W. Kellogg is putting in the piping, laundering, and wiring. Also under way is work on the steel over the silos and on the conveyors. There will be three regrind silos and three fine ore silos, each of which have a diameter of 45 feet and are 34 feet high. The concentrate will be conveyed on a 30-inch belt 416 feet to

the pelletizing plant. At the secondary and tertiary crushing plant, a Symons seven foot standard cone crusher and a Symons seven foot shorthead cone crusher are being added.

When the new section of the concentrator starts operating in January 1962, Western Knapp Engineering Company will start construction of a duplicate 800,000-ton per year section that is scheduled for completion in October 1962.

At the pellet plant, most of the steel as well as the 15 foot diameter, 114 foot long kiln have been installed. The contractor, Arthur G. McKee & Company, is working on enclosing the balling and bin area at the upper end and the grate and cooler area at the lower end.

Abe W. Mathews Company Engineering is designing and building the pellet loading section.

When the expansion of Republic is completed in the fall of 1962, the mill will have a capacity to produce 2,400,000 tons of high grade iron ore concentrates per year, and the agglomerating plant will be capable of pelletizing 1,600,000 tons annually. The excess 800,000 tons of concentrate will be pelletized at Cleveland-Cliffs' Eagle Mills agglomerating plant about 20 miles east of Republic.

Jones and Laughlin Steel Corporation is expanding its **Lind Greenway** mine at Coleraine, Minnesota. Present facilities include a washing plant; however, because the mine is rapidly being depleted of wash ore, a heavy media section and a jig section are being added. Work is already under way and initial operation of the new sections is scheduled for the start of the 1962 shipping season. Contractor for the expansion is **Roberts and Schaeffer Company of Chicago,** Illinois.

Erie Mining Company, Hoyt Lakes, Minnesota, is operating at its rated capacity of 7,500,000 tons of pellets per year. To do this, the mining firm is operating seven days per week from three open pits. Transportation of the crude broken taconite is done by railroad haulage in 80-ton capacity side-dump cars for delivery to the primary crusher. To meet the rated capacity of the mill, the pits are producing a combined total of some 60,000 tons of taconite per day. The taconite pits at Erie are east and west of the central plant area that consist of crusher, fine crusher, concentrator and pellet buildings.

Montana

Boulder Lake Corporation has commenced diamond drilling on its leased property, **Boulder Cobalt** claims, also known as the **Pollinger** group of claims, located in the Tobacco Root Mountains about 10 miles southeast of Silver Star, Montana. Rebuilding work on 4.5 miles of road has been completed, and plans are to continue diamond drilling through the winter months. Robert T. Judd is manager of the operation.

The **Mouat** mine of the **American Chrome Company** near Nye, Montana, was closed down recently when the company completed its 90,000-ton government contract. The company has been conducting experiments on ways to make a marketable product from chrome concentrate, and some of the test results have been encouraging. Thus management hopes the mine will be reopened sometime in the future.

Montana-Coeur d'Alene Mines, Inc., has been organized by Spokane, Washington, and Long Beach, California, people to develop lead-copper-silver prospects in the Eddy Creek mountain district, Mineral County. The properties include the **Johnny Miller** and others worked about 60 years ago. They are about 10 miles from the **Nancy Lee** mine where the **Bunker Hill Company,** big Idaho mining and smelting firm, is undertaking a deep development program. The claims were acquired from **State Mining Company** of Spokane. Road construction and diamond drilling are planned. Firner Walkley, Spokane, is chairman of the board.

The Anaconda Company has awarded the contract to sink a 1,700-foot ventilation shaft at the **Never Sweat** mine in Butte, Montana, to the **Centennial Development Company** of Eureka, Utah. The 22-foot-wide, concrete-lined shaft will enable Anaconda to increase production facilities.

Nevada

First 100,000,000 Tons Mined at Anaconda's Weed Heights

During October the 32,000,000th ton of copper ore was mined from the Yerington pit at Weed Heights, Nevada. At the same date 68,000,000 tons of waste had been removed so Yerington has now started on its second 100,000,000th ton. Leaching operations began in 1953 and to the first of October 1961 235,000 short tons of copper have been recovered which would have a value of $182,400,000 based on the average price of copper during production.

The new sulphide flotation plant with a capacity of 5,000 tons per day has recently been commissioned and is scheduled for full operation in early 1962. Oxide ore tonnage has been cut back so that total daily ore tonnage remains the same. Copper production will remain the same or possibly increase slightly in 1962. A. E. Millar, general manager, has supervised all operations since the project was authorized by Anaconda's board of directors.

Tempiute Mining Company of Las Vegas, Nevada, plans to mine silver in Lincoln County. According to Donald Scheitwiler, secretary-treasurer, the company has developed a large silver deposit, and upon completion of the mill will begin operations with several hundred tons of stockpiled silver ore.

The first phase of core drilling in the Ruby Hill area of the Eureka district, Nevada, has been completed by the **Ruby Hill Mining Company.** The second phase of exploration, involving a substantial cash contribution on part of the principals in Ruby Hill, will be delayed until the first months of 1962 to allow time to thoroughly interpret first phase results, which are reported to be encouraging. Participants in the Ruby Hill Mining Company include the **United States Smelting, Refining & Mining Company, Cyprus Mines Company, Newmont Mining Corporation, Hecla Mining Company,** and **Eureka Corporation.**

Nevada Mines Division of **Kennecott Copper Corporation** is conducting a deep hole drilling program in the Ruth area, White Pine County, to test for ore potentials between 1,000 and 3,000 feet below the present open pits. The first diamond drill hole was drilled from the bottom of the **Liberty** pit, with other drills expected to be assigned to the program at a later date.

New Mexico

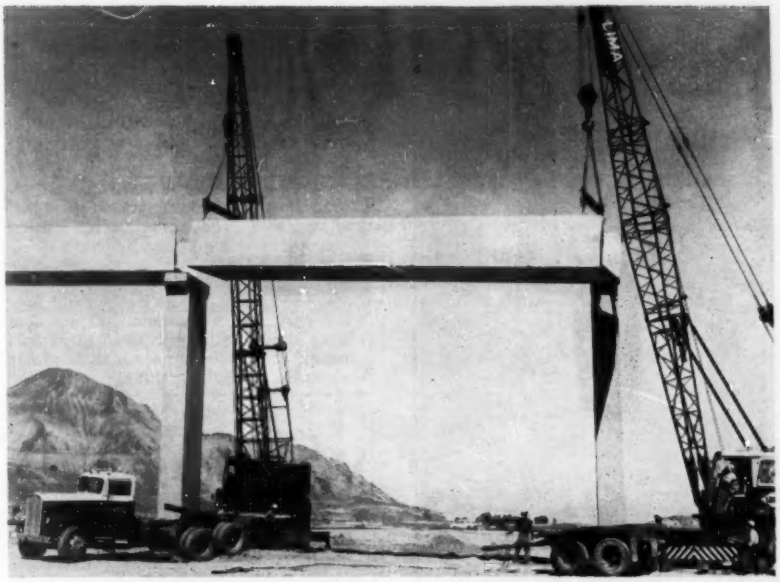
Kerr-McGee Forms Partnership to Mine Carlsbad Potash

Kerr-McGee Oil Industries, Inc. and National Farmers Union Service Corporation of Denver, Colorado are forming a new company to mine and mill potash reserves near Carlsbad. The new enterprise, Kermac Potash Company, will be a partnership in which a wholly-owned subsidiary of each parent company will have a 50 percent interest. A large-scale pilot plant program is being launched immediately at Kerr-McGee's metallurgical research laboratory at Golden, Colorado, to finalize engineering-design plans for a 1,500-ton-per-day potash plant on which construction is to be started at the earliest possible date, Kerr-McGee will be operating partner for all phases of the new venture.

A circular shaft was completed several years ago to the potash bed and large scale samples were obtained for metallurgical testing. By normal Carlsbad Basin standards the ore is "dirty" with clay and slime which complicates milling.

The new ventilating shaft at **Homestake-Sapin Partners' Section 25** uranium mine in the Ambrosia Lake district went into service recently when two 125 horsepower electric motors were turned on. The new ventilating unit joins two others that have been providing 58,000 cubic feet of fresh air per minute into the Section 25 mine underground workings. The new volume of fresh air entering the mine is now approximately 200,000 cubic feet per minute. According to a company spokesman, this will provide more than adequate air for the expanded workings of the mine, and will continue to keep the level of radon gas at safe levels.

Kermac Nuclear Fuels Corporation's five mines in the Ambrosia Lake district, and the **Branson 33** mine of **Ambrosia Lake Uranium Corporation**, are producing at a rate sufficient to meet the controlled ore requirements of the Atomic Energy Commission contract. This group of properties is producing ore in excess of 100,000 tons per month which is adequate to fill the A.E.C. contract. In addition, a substantial stockpile is being established.



Kennecott Builds Concrete Tailing Flumes

Kennecott Copper Corporation's Utah Copper division has installed three new tailing discharge launders at its flotation mills, two at Magma, each 160 feet long, and one at Arthur 590 feet long. All flumes are made of prestressed precast concrete and the three are designed to carry 87,000 tons of tailings per day to the pond below the mills. The picture above shows one of the eight-foot-wide by four-foot-deep sections being placed atop concrete supporting piers which are about 42 feet high. A total of 19 individual sections were used for the three flumes with each section weighing from 30 to 42 tons. Precast lid sections were placed on top of the completed flumes by the same cranes.

Utah

Vitro Minerals Corporation plans to build a 10 ton-a-day pilot plant in Salt Lake City, Utah for the reduction of Spors Mountain beryllium ores. Metallurgical and processing work on the laboratory level has been successfully completed, and it is now necessary to prove results on a volume basis, accordingly to Gauin H. Young, general manager of Vitro.

United Chemetrics Inc., formerly **United Heckathorn, Inc.,** has closed its artificial cryolite plant at Garfield, Utah. Cryolite was produced through the recovery of fluorides obtained from the processing circuit of the fertilizer plant of **Western Phosphates, Inc.**

Sinking of the new 2,800-foot circular shaft to develop the **Cane Creek** potash mine of **Texas Gulf Sulphur Company** is on schedule. **Patrick Harrison International** is sinking under contract. To speed sinking and prevent water inflow the upper 1,500 feet of rock around the shaft will be grouted.

New Park Mining Company and affiliated **East Utah Mining Company** are dealing with the **Mammoth Mining Company** and associated firms on a major nonferrous metal search in the Eureka area. Work will be carried on in three phases under the agreement now being perfected, and some 700 acres of mining claims will be involved in exploration off the 2,300-foot main shaft of the **Mammoth** gold-silver mine.

Washington

At the **Schumaker** zinc-lead mine northeast of Colville, Stevens County, **Goldfield Consolidated Mines Company** of San Francisco, California is stockpiling ore being taken in drift work on a 21-foot vein intersected as anticipated at the 1,265-foot point in the new lower adit. A raise to the upper tunnel, where the vein first was discovered, was holed through previously. At last report, work was continuing on a three-shift basis and consideration was being given to mill construction. Goldfield took over development work last summer under a profit-sharing agreement with **Triton Mining Company**, Colville. Willis Swan is president of Goldfield and Darrell A. Newland heads Triton.

Silver Hill Mines has made its first shipment of tungsten concentrates, 16 barrels worth an estimated $20,000, from its property five miles south of Spokane to **Wah Chang Smelting & Refining Company**, Glen Cove, New York. Robert N. Roby is mining engineer and J. D. Kelley, mill superintendent.

After driving 1,070 feet of tunnel in 54 working days at the **Shumaker** lead-zinc property on Joe Creek, northeast of Colville, Stevens County, **Goldfield Consolidated Mines Company** started a raise to intercept an ore body opened in a higher elevation. The new 800-foot adit will then be extended an additional 240 feet to pick up the ore zone on its downward dip. Cy Higginbotham, Colville, is in charge of operations for Goldfield.

Harold V. Davidson, Reardan, Washington, and Elmer Cook, Republic, Washington, recently reopened the old No. 1 Mohawk tunnel near Conconully, Okanogan County. At last report they were stockpiling lead-silver development ore for shipping by truck to the Trail, British Columbia, smelter. They leased the upper workings of the Mohawk from **Sunny Peak Mining Company** of Spokane. The company has made preparations to erect a compressor house at the lower tunnel on the adjoining Gubser property. C. J. Weller, Coulee City, is company president and Mrs. E. I. Fisher, Spokane, secretary.

Lavender Pit . . .

continued from page 18

TRIPPER CAR atop fine ore storage at concentrator automatically fills entire length of 10,000 ton bin as mill superintendent Phil Allen watches.

been engraved on a graphic panel. Colored lights indicate the various conditions of activity—or inactivity. Push light control button switches are used on the panel. The "start" control for a belt is placed in the head pulley symbol, and the "stop" control for a particular belt is placed in the tail pulley. The emergency "stop" function for any particular belt is placed in the middle of the belt graphic symbol.

Inside the control cabinet both alternating current and direct current relays are used. To prevent maintenance personnel plugging a DC relay into an AC socket, all relays of the AC type are double-pole, double-throw relays mounted on an octal base; whereas all DC relays are three-pole, double-throw, and mounted on an 11-pin base. This makes errors in replacing relays impossible.

Information Panel Unique Aid

Electronic control and efficiency in the Lavender Pit mill, however, does not stop at the fine ore storage bin. The ultimate innovation is a visual information panel in mill superintendent Phil Allen's office. Here, a small panel shows with lights the exact activity status of the major equipment in the concentrator. There are red and white lights for the primary crusher, the two secondary crusher sections, the eight primary ball mills, and finally the concentrator's four regrind ball mills. Red lights on indicate equipment is running; white lights on indicate units

INFORMATION panel shows current activity status of mill equipment.

are shut down. There is also a small timer measuring operating time of pan feeders under coarse ore bins from which tons per hour may be calculated. With this information panel constantly "on the job", along with the other modern equipment of the crushing circuit, efficiency at the Lavender Pit mill has hit a new high.

The management of the Phelps Dodge Corporation, and mill superintendent Phil Allen and his staff, particularly mill electrical supervisor Bill Peartree, are to be congratulated for having the foresight and inventive capacity to install unique control equipment that helps keep costs down and production up.

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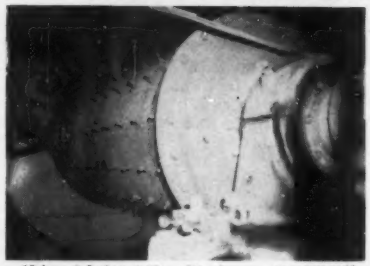

6½ x 12'1" Allis Chalmers Rod Mill

Agitators
1—12 x 10' Denver Mechanism, 30HP, 440V
1—15' x 9' High Lift, Steel Tank

Bins
1—40 Ton Cone, Steel
1—300 Ton Steel, 4 compt., steel column
1—1000 ton 30' dia., Riveted steel

Blower
3—2" Roots Positive Pressure, 3HP

Box Car Loader
1—24" Stephens Adamson 3HP, 440V

Car, Mine Ore
350—45 cu. ft. Rotary dump type, 24" ga. Complete with Rotary Dumps

Classifiers
1—12" x 10'—0" Akins Spiral, 1½ HP, 440V
2—48" x 20'—3" Wemco Spiral, 5HP, 440V
1—48" x 20'—3" Wemco Spiral, Flared Tank, 5HP
1—72" x 24'—6" Akins Spiral, 7½ HP. Near new

Compressors
1—750 cfm I.R. XCB, 150 HP, 440V
1—1000 cfm I.R. XPV, 200HP, 220V
1—1100 cfm Worthington, 220HP Syn., 440V

Conveyors
1—16" x 55' Steel Frame, less belting
1—16" x 125' With 5 ply Belt, 3HP
1—18" x 18'—2" Shuttle belt, with SA Box Car Loader
1—18" x 100' Steel Frame, less belting
1—24" x 25' 5 ply Belt, 3HP, 220/440V
1—24" x 38' 5 ply Belt, 17HP, 220/440V
1—24" x 85' 5 ply Belt, 25HP, 220/440V
1—24" x 100' 20 HP, 440V
1—24" x 115' Steel Frame, 5 ply Belt, 10HP
1—24" x 150' Steel Frame less Belting
1—24" x 180' 5 ply Belt, 40HP, 440V
1—24" x 290' Joy Sectional, Steel Frame, Less Belt
1—24" x 340' Robins, Steel Sectional, Less Belt
1—32" x 60' Steel Frame, 40HP, 220V
1—36" x 140' Steel Frame, less belting
1—48" x 30' Apron Conveyor, 3/16" pan

Crusher, Jaw
1—15" x 24" Allis Chalmers, Blake Type, less motor

Crushing Rolls
3—15" x 36" Allis Chalmers, less motor
1—16" x 36" Allis Chalmers, 200HP motor

Crusher, Reduction
1—9E Telsmith Reduction Gyratory, 100HP

Drills, Rock
50—HC10 Cleveland, 1" hex. w/airlegs

Elevators, Bucket
1—72' General Conveyor Co., 24" x 15" x 18" Buckets
1—34' Jeffrey, 6" x 4" buckets, 2HP

Feeders
4—24" x 23½' Rubber Belt, Steel Frame 5HP
1—20" x 30' Rubber Belt Shuttle, 3HP
1—36" x 72" Jeffrey Traylor, Vib. Grizzly, 440V
1—30" x 60" Jeffrey Traylor, Vib. Pan., 440V

Filter
1—60 sq. ft. Eimco Horizontal Pan Filter, Stainless

Generators
1—5KW Allis Chalmers 250V DC
1—12½KW Electric Machinery 250V DC
2—15KW Chandeyson 150V DC
1—150KW Reliance 250V DC

Hammer Mill
1—40" x 40" New Holland, Impact Breaker

Headframes
1—70' All Steel, Double Compartment, vertical
1—90' All Steel, Double Compartment, vertical
1—50' All Steel, Double Compartment, w/200 ton Bin

Hoists, Mine Shaft
1—50HP Denver Eng. WKS, 440V, 1-Drum
1—40HP Ottumwa, 1-Drum, 440V
1—100 HP Ottumwa, 1-Drum, 440V
1—150HP Ottumwa, Cylindro-Conical, 2200V
1—250HP Ottumwa, 2-Drum Conical, 440V
1—300HP Nordberg, Double drum, 440V, New Drums

Hoists, Slushers
2—40 NM4C Ingersoll Rand 2 Drum 40HP 440V
6—50 NM4C Ingersoll Rand 2 Drum 50 HP 440V
4—CF312 Joy, 3 drum, 60HP, 440V

Jigs
2—24" x 36" Denver Equip. Co. Duplex, Mineral
3—36" x 48" Denver Equip. Co. Duplex, Mineral

Locomotives, 24" ga
3—4 ton Westinghouse, Trolley, 250V
1—5 ton Westinghouse, Trolley, 250V
8—6 ton Goodman, Trolley, 250V
2—6 ton General Electric, Trolley, 250V
1—6 ton Jeffrey, Trolley, 250V

Magnet
1—37" dia. Cutler Hammer, w/Control

Mills, Ball & Rod
1—5' x 9' Allis Chalmers, Ball, 100HP, 440V
1—8' x 6' Kennedy Van Saun, Ball, 250HP
1—86 Marcy, Ball, 225HP, 440V
2—6' x 4' Allis Chalmers, Ball, 100HP, 440V
4—4' x 10' Allis Chalmers, ROD, 50HP, 440V
1—5' x 9' Allis Chalmers, ROD, Less Motor
3—6½' x 12'—1" Allis Chalmers ROD, 240HP, 440V

Pumps
1—12 x 12 Allis Chalmers, Centrifugal, 90HP, 440V
1—12" Worthington, 150HP, 2200V
1—12" Dayton Dowd, 125HP, 2200V

Pump, Diaphragm
2—4" Dorrco Duplex, VM, adj. Stroke.

Pumps, Sand
3—2" Wilfley, Model C, 5HP 440V
5—3" Wilfley, Model C and K., 5 and 10HP
2—4" Wilfley, Model C. K. 15HP 440V
3—6" Wilfley, Model C and K Less motors
1—6 x 6 Denver SRL, 20HP 440V

Pumps, Vacuum
5—14" x 5" Ingersoll Rand, ER-1 15HP
1—12" x 10" Chicago Pneumatic 75HP 440V
2—14" x 8" Oliver, V-Belt Drive

Scales
2—150 ton Fairbanks Morse Railroad, 10' x 50'
1—50 ton Winslow Truck, 9' x 34'

Screens
1—3' x 6' Deister, 1 deck 3HP 440V
36—3' x 5' Single Deck 2HP 440V
1—3' x 10' Tyler "Hummer", V-16 Vibrators, 1 deck

Separator
1—Size 20 Rotoclone Hydrostatic, Type N.

Tables
149—Deister—Plato, 6' x 14'
53—Butchart Full Size, less motors

Thickener
11—40' door Thickeners, 2HP

Truck
1—7½ yd. Autocar, w/Omaha Standa-rd Hopper Trailer

Weightometer
4—24" Merrick Model E, Complete

ADDITIONAL ITEMS — JUST RECEIVED

Blower
1—60" Model 60-36V Joy Axivane, 100HP

Concentrator
2—24" Knudsen Centrifugal, Gold

Crane
2—2 ton Shaw Box overhead Electric, 17'-6" span

Crushers
1—2033 Cedar Rapids Hammermill
1—36" x 36" Jeffrey Single Tooth Roll

Drill, Diamond
1—Long year No. 24 Complete with truck

Feeders
1—60" x 16'—3" Pioneer-Oro, Apron, 20HP
1—36" x 72" Jeffrey Vib. Pan, 4H, 440V
1—4' x 10' Stephens-Adamson, Plate 15HP

Filters
1—4' x 6' Eimco Drum, Stainless steel
1—6' x 3 disc Eimco, Stainless, Reconditioned
1—4'—2 disc Eimco, Complete, ½HP 440V
1—4' x 5' Denver Drum, ¾HP

Flotation Machines
1—6 cell Wemco, Size 60" x 62", 15HP Excellent
1—4 cell Wemco Fag., 28" x 28", 1½HP
1—8 cell Wemco Fag., 28" x 28" 1½HP

Pumps
2—1" Ingersoll Rand 1VHTB, 25 gpm @ 2310', 40HP
2—4" Bingham, Type CA, Less motor

Pumps, Vacuum
1—12" x 10" Ingersoll Rand ER1, 30HP
2—Size L6 Nash-Hytor 25HP 440V

Screen
1—3' Symons "V" Model V3
1—6' x 14' Hewitt Robins, MH-11, Scalping

Turbo Mixer
1—#3B Turbo Mixer, 8' dia., Stainless #316

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1—Vulcan 10' x 11' x 175' kiln, 13/16", 2-tire
1—10' x 8' x 125' kiln, ⅝" shell
3—10' x 100' dryer, ⅝" welded
2—10' x 78' dryers, ¾" shell
2—8'-6" x 70' rot. dryers, ⅝" welded
1—Traylor 8' x 80' dryer, ⅝" welded
3—Stearns-Roger 8' x 40' dryers, ½"
1—7'-6" x 63' rotary kiln, ½" welded
1—Allis-Chalmers 7' x 120' kiln, ⅝" welded
2—7' x 110' rotary kilns, ⅝" shell
1—7'-6" x 62' cooler, ½" welded
1—7' x 6' x 100' rotary kiln, ½" shell
1—6' x 150' kiln, ⅝" welded
1—4'-6" x 40' kiln, ⅝" welded

MILLS — PULVERIZERS — CRUSHERS

1—Marcy #64½ ball mill, 100 HP.
1—Symons 2' shorthead cone crusher
1—Symons 2' standard cone crusher
1—Allis-Chalmers 6' x 12' rod mill
1—Bonnot 5' x 10' ball mill, 75 HP.
1—Hardinge 8' x 48" conical pebble mill
2—Hardinge 7' x 36" conical pebble mills
1—Raymond 66", 6-roller hi-side mill
3—Allis-Chalmers 5' x 22' ball-tube mills

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OPEN PIT ANTIMONY — High grade deposits (2) one developed. S.E. California. Good roads, near rail. Veins 1" to 15". Smelter contract available. Sale or lease. Box 82, Jean, Nevada. RE 5-1301, Las Vegas.

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Engineer experienced in Ore Beneficiation Plant layout design and capital cost estimating. Excellent opportunity. Location: Northern Minnesota. Reply Box 128, MINING WORLD, 500 Howard St., San Francisco 5, Calif.

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FOR SALE — Wagon drill rig, truck mounted G.D. 365 compressor and 18' chain slide powered by NH200 Cummins Engine. Interchangeable air motor for rotary drilling to 300' depths. All in top condition. Box 1435, Casper, Wyoming.

WANTED — Used heavy-media plant complete. Seven (7) foot cone with proper sized equipment. Calvert City Chemical Co., Box 50, Marion, Ky.

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MARKET PLACE

Two Canadian Prospects Show Good Molybdenum Potential

Initial exploration of two important molybdenite prospects of Preissac Township, northwestern Quebec, Canada, has proved encouraging and both Anglo American Molybdenite Mining Corporation and Preissac Molybdenite Mines hope to make a production decision by this fall.

Anglo American, under the management control of Dumont Nickel Corporation, has opened negotiations with a large American company (rumored to be American Metal Climax, Inc.) to provide financing of $4,000,000 for construction of a permanent mining plant and a 1,000-ton-per-day mill, if underground development proves sufficient ore reserves. It is probable that such a loan would be based on repayment out of production delivered against a firm sales contract. If negotiations are successful, the company expects to begin mill construction this fall.

Shaft sinking at the mine, on the west shore of Preissac Lake about 15 miles north of Cadillac, has been completed to 375 feet with stations cut at the 150-foot and 300-foot horizons. Development will crosscut about 400 feet north from the shaft on the 150-foot level to intersect a series of east-west striking quartz veins and stringer zones found by surface diamond drilling.

Reserves, indicated by surface drilling, are found in two types of occurrences on the property. One is a series of east-west quartz veins, containing an estimated 579,000 tons having an average grade of 0.60 percent MoS_2 and 0.087 bismuth. The larger occurrence, a north-south striking pegmatite dike, has been estimated at 834,166 tons with an average grade of 0.47 MoS_2 and 0.045 bismuth. Additional reserves of 1,315,937 tons, available for open pit mining, is indicated in the wider north portion of the pegmatite dike, with an average grade of 0.32 MoS_2 and 0.034 bismuth.

Preissac Molybdenite Mines, a subsidiary of Molybdenite Corporation of Canada, reports that underground development is encouraging, proving the expectations of diamond drilling although the structures are somewhat different than originally indicated. Reserves, on the basis of original surface drilling, were estimated at 1,250,000 tons averaging 0.58 percent molybenite and 0.02 bismuth.

A three-compartment vertical shaft was completed to the depth of 615 feet this spring with levels at the 200-foot, 325-foot, 450-foot and 575-foot horizons. Lateral development on the 450-foot and 575-foot levels is currently underway, and crosscuts driven west from the shaft have so far intersected three vein structures.

While drifting is proceeding on both levels, the company has also begun underground diamond drilling with two machines, in a program of inter-level drilling to establish vertical continuity and to block out tonnages in the known veins.

The company hopes to be able to reach a decision regarding production, on the basis of current development, by late summer. If estimated ore reserves prove to be correct, plans call for a 1,200-ton-per-day-mill and permanent mining plant construction to begin in the fall.

...a saving of 15 hours labor and productive time with the C-6 and no special tools required!

C-6		Crawler "C"	
Planetary Gears	3 hours	Gears and Bearings	16 hours
Inside pinion and drive gear reduction	11 hours	Top pinion from steering clutch with bearing and shaft	13 hours
Total	14 hours	Total	29 hours

Times shown are for removal and replacement of final drive with all components in place.

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The Euclid dealer in your area would like to prove that the C-6 is the lowest cost tractor in the 200 h.p. class . . . and the most versatile by far. He's sure of it, and wants you to know the facts, too!

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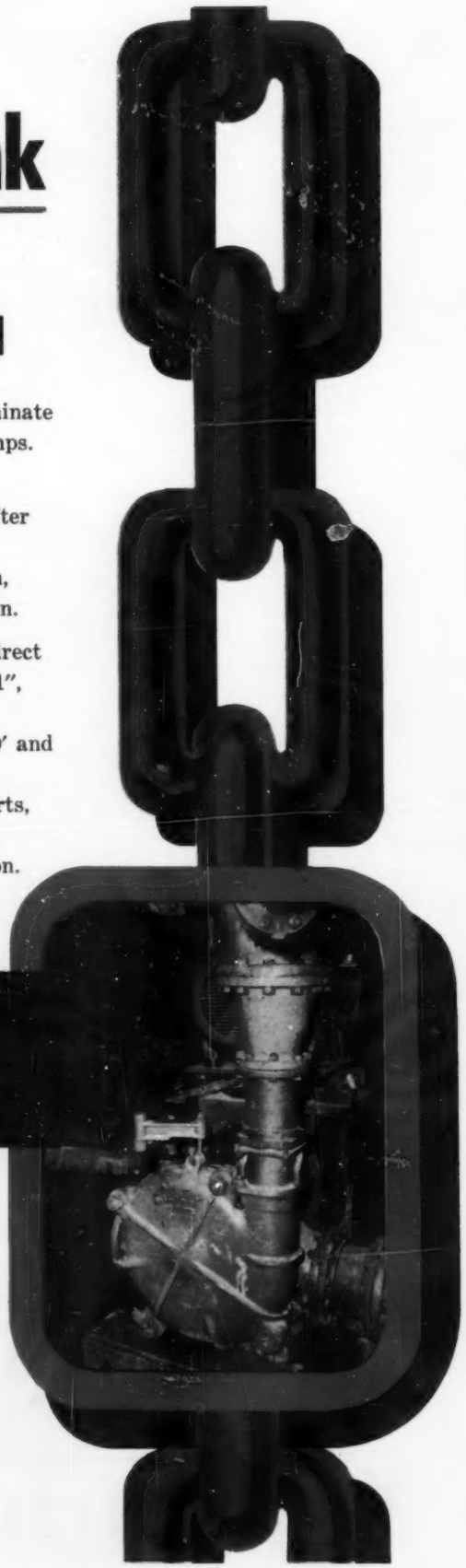

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